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THE NATURE OF THE X RAYS OF RÖNTGEN.

By J. J. STEWART, B.A.Cantab., B.Sc.Lond.

PROBABLY at no period in the history of science has so much research been concentrated on one particular part of the field of investigation as now, when in all the principal physical laboratories of Europe inquiries are being made into the effects and the probable causes of the remarkable new species of radiation labelled by one of the early discoverers X, or unknown. To able and well-directed efforts thus persistently made, "the rays" will no doubt soon be obliged to yield the secret of their origin and cause. In fact, already there are clear indications of the direction in which the truth may be discovered, and the researches of explorers in several widely separated countries are converging on one definite explanation of the source of this mysterious phenomenon. Opinions, however, amongst those competent to judge are still in many quarters widely different.

Recently amongst our neighbours the French, who have been active in physical research, a form of radiation has been brought to notice which differs from ordinary light and is different also from the rays described by Röntgen. This newly-found form of ethereal vibration appears to possess characteristics intermediate between those of light which affects our eyes and those associated with the X rays. Most people have seen in the shop windows, or elsewhere, yellow or canary-coloured glass, sometimes made into small trays or dishes. It possesses a peculiar fluorescent property, and when light of any colour whatever falls upon it, it glows with its own peculiar and weird phosphorescent yellowish light. This property of the glass is remarkably shown by placing a rod made from it in a dark room and forming a spectrum of some source of white light. When the rod is placed in the red or the blue part of the spectrum, it still persists in giving back its characteristic yellowish shimmer. The cause of this behaviour in the glass is the presence in it of salts of the somewhat rare metal *uranium*. Now, M. Henri Becquerel, in France, has been carrying out investigations on the nature of the radiation given out by various salts of uranium, and has shown the existence of radiation intermediate in character between that of light and that which probably causes the Röntgen effects. M. Becquerel made a fluorescent screen of thin crystals of the double sulphate of uranium and potassium, a substance which is very active in its phosphorescence. This phosphorescence or visible emission of light lasts a very short time, less than one-hundredth of a second; but the fluorescent screen appears to have also the power of giving forth invisible phosphorescent radiations. Light from the sun after passing through such a screen can cause the formation of an image on a sensitive film, although black paper or aluminium is interposed in the path of the solar radiations. Copper is, however, almost opaque to these radiations. Moreover, a film left in the dark, with the phosphorescent screen almost touching it, shows intense images. These latter are not produced by any visible light, and must be due to the invisible phosphorescence. The persistence of the emission of these dark radiations from the uranium salt is most extraordinary. After being kept in the dark for a fortnight the screens formed from the salt emit their radiations with scarcely less intensity than when freshly exposed to light. These uranium radiations discharge electrified bodies just as Röntgen rays do; they also suffer the same sort of diminution in intensity as the rays of Röntgen on traversing a plate of quartz. Their action, however, has only about one-hundredth part of the intensity of that of the Röntgen rays. Various salts of uranium exhibit the same properties.

The special interest attaching to these experiments at present is due to the fact that M. Becquerel finds that the uranium radiations can be refracted and polarized. Now, this polarization proves that the radiation must consist of *transverse* vibrations; and as Röntgen radiation is similar in many respects, a presumption arises that the Röntgen rays themselves are caused by transverse vibrations in the ether. Recent work shows distinct evidence that the Röntgen rays can be reflected. These rays, then, possess some of the properties of ordinary light.

An Italian investigator, Signor Righi, finds that when a body charged with negative electricity is exposed to the action of Röntgen rays it loses its negative charge, which appears to leak away; and when longer exposed to the same influence it gains a positive charge instead. Invisible rays from the part of the spectrum beyond the violet exert a similar action, and there is thus shown to exist another property common to those two sorts of radiation.

Other observers have found that the light given out by phosphorescent bodies is able to penetrate substances which are quite opaque to ordinary light from the sun. Diffuse reflection of Röntgen rays seems to have been distinctly observed, and images of opaque objects have been produced by means of reflected rays when the sensitive plate on which the images were formed was screened from the direct action of the vacuum tube by means of a thick sheet of copper placed between the tube and the plate.

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The Röntgen rays are probably of various wave-lengths, and are not analogous to light of one definite colour. The absence of any phenomena of diffraction does not, therefore, prove that they are not ultra-violet vibrations. Before diffraction experiments can be successfully performed a means must be found for sifting the Röntgen rays, and separating out the components differing in wave-length.

The evidence that irregular reflection of Röntgen rays occurs is accumulating, and, so far as can be judged at present from the results of the numerous experiments already carried out, it seems probable that this newly discovered form of radiation will turn out to be a form of transverse vibration in the ether of much smaller wave-length and more rapid than that which produces ordinary light.

It must be remembered that the visible vibrations constituting light have a range, from the dark red, or slowest, to the violet, or most rapid, of about an octave. Vibrations which are a little more than twice as rapid as those of red light do not affect our eyes. There is no reason to suppose that disturbances or changes in the ether many times as quick as those of red light do not exist. Some of these ultra-violet vibrations have already been investigated and have become known, and it may well be that some still more swift and hitherto unsuspected vibrations have been manifesting their existence to us by the effects first noticed by Lenard and Röntgen, and since so diligently investigated by the numerous observers who have followed them.

BRIEF DESCRIPTION OF THE ORCHID PHOTOGRAPHS.

By H. A. Burberry, F.R.H.S.

THE accompanying illustrations are from photographs of a few specimens from the Right Hon. J. Chamberlain's collection of orchids.

Fig. 1 represents a specimen of *Cattleya mossiæ*, variety *Wagneri*, a very rare and most beautiful orchid. It is a native of Venezuela, and thrives best when grown in an intermediate temperature. The species as a whole is a richly and most varied coloured one. The variety *Wagneri* is the pure white form. The section to which this plant and *Cattleya mendelii* (to be described later on) belong is the "labiate" section, so named on account of the very large and beautiful lip, or labellum, which is a characteristic of the plants. All species belonging to this order have their pure white varieties, which are in all instances very rare and costly.

Fig. 2 is a specimen of *Cypripedium bellatulum*, a species coming from Cochin China. The flower is very striking, the ground colour being white and the whole densely spotted with brownish purple. The plant succeeds best in an intermediate temperature, and should be grown in a compost of strong loam mixed with limestone.

The genus *Cypripedium*, to which belong the so-called "lady's slipper orchids," is a very large and popular one, inhabiting both Asia and America. Those from the North of America are quite hardy. There is, moreover, one (*C. calceolus*) that is a well-known European species, and was once a wild plant in England, but has now become exterminated.

Fig. 3 is a very beautiful orchid coming from Burmah, and called *Dendrobium formosum giganteum*. The genus to which it belongs is a very large one, and species belonging to it are found scattered nearly over the whole of the continents of Asia and Australia. They are for the most part very warm-growing orchids, and the species here depicted always requires the warmest department and grows best planted in small pans suspended from the roof. It flowers during August and September. The flowers are pure white, with the exception of an orange blotch on the labellum, and are borne at the apex of the newly-formed pseudo-bulbs.

Cattleya mendelii, a specimen of which is shown in Fig. 4, belongs to the same very popular genus as the subject of Fig. 1. The genus was founded in honour of

Fig. 5.—*Miltonia vexillaria.*

William Cattleya, of Barnet, Herts, who was a great lover of orchids in his day. *C. mendelii* is a very attractive and showy orchid, and is one of the most lovely of them all. The flowers are of great beauty and most delicately tinted, from light pink to a deep rose colour. Its native habitat is New Granada. The temperature most suited to its requirements is an intermediate one. It flowers in April and May, and grows best when planted in peat and sphagnum moss.

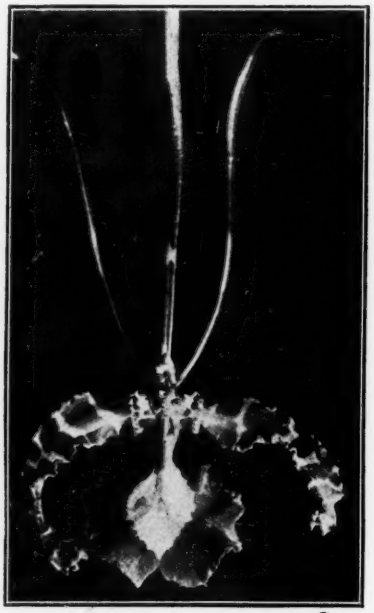

Fig. 6.—*Oncidium papilio.*

The genus *Miltonia* (named after Viscount Milton, afterwards Earl Fitzwilliam) is one containing several very beautiful orchids, some preferring the temperature of the warmest house, and others the intermediate house temperature. *M. vexillaria* —Fig. 5—from New Granada, is one of the latter. It is sometimes known as the "standard-bearer orchid." It is one of the most showy and beautiful of the genus,

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PHOTOGRAPHS OF ORCHIDS.

From the Collection of the Right Hon. JOSEPH CHAMBERLAIN, M.P.

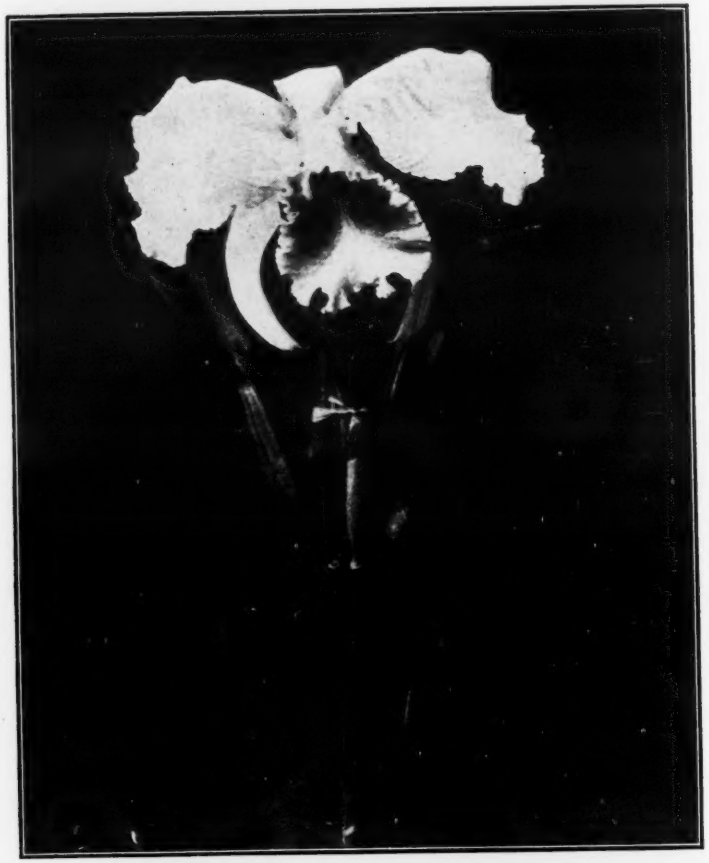

Fig. 1.—Cattleya mossiæ, var. Wagneri.

Fig 2.—Cypripedium bellatulum.

PHOTOGRAPHS OF ORCHIDS.

From the Collection of the Right Hon. JOSEPH CHAMBERLAIN, M.P.

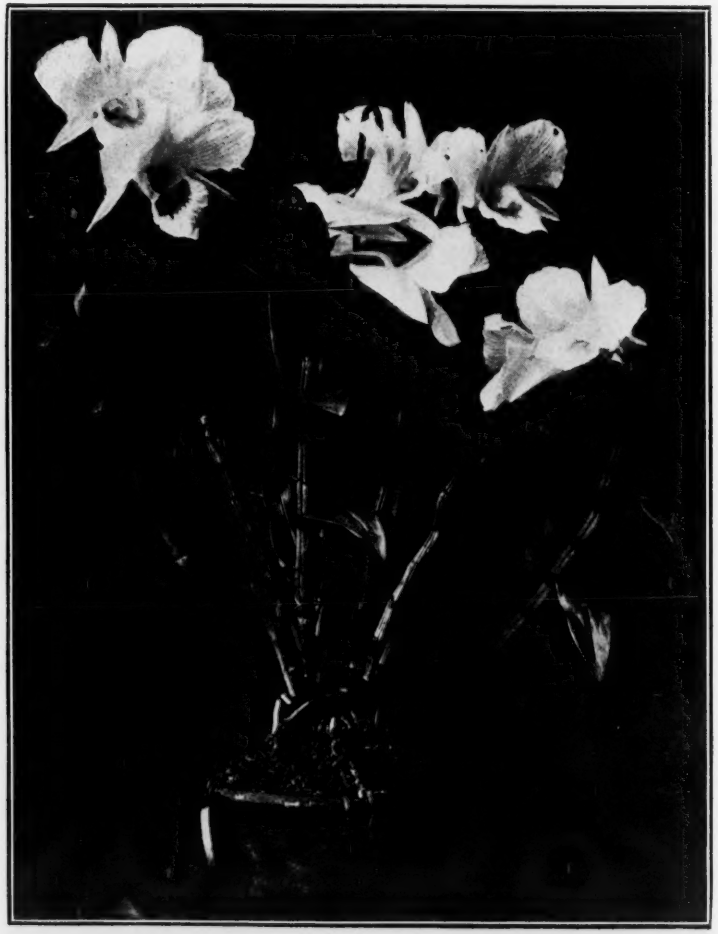

Fig. 3.—Dendrobium formosum giganteum.

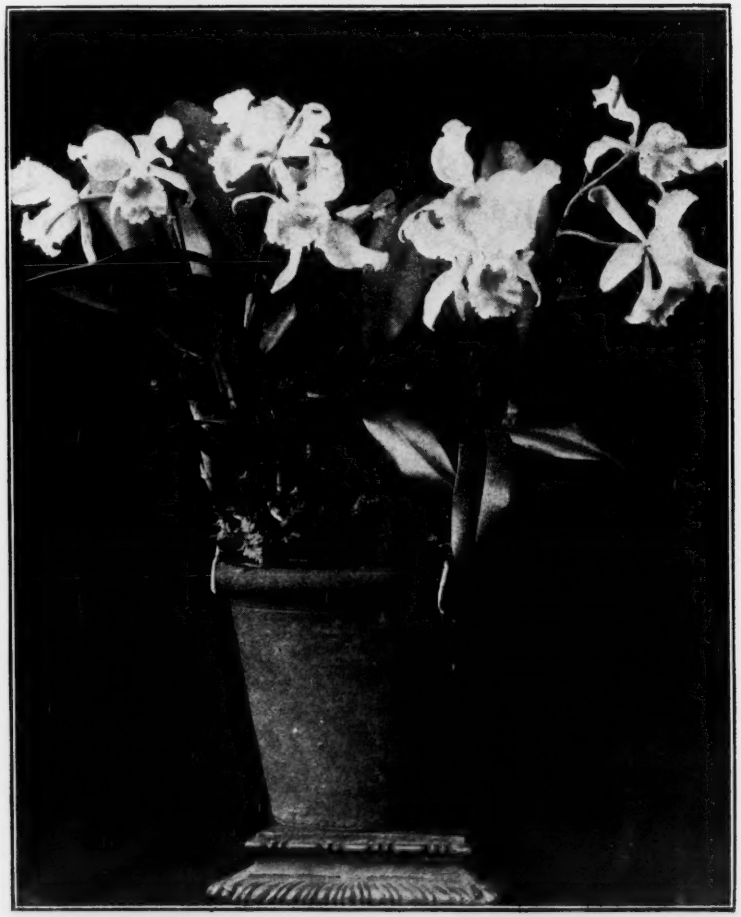

Fig. 4.—Cattleya mendelii.

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and if cultivated under proper conditions makes rapid growth. It is best grown in sphagnum moss and fibrous peat. There is great variety of colour, which varies from almost white to a very dark rose.

The genus *Oncidium* is a very large one, comprising over two hundred and fifty species, and inhabiting tropical America and the West Indies. Some are very cool-growing kinds, and require only the ordinary greenhouse in which to flourish, whilst others must have more warmth. *O. papilio* is one of the latter, and must have the warmest house. It is generally known as the "butterfly orchid," and it certainly resembles a large butterfly in shape. The flowers are pale golden yellow, barred with chestnut brown. It may either be grown fixed on a block of wood, or in a wooden basket planted in sphagnum moss and fibrous peat. It is a compact-growing plant, and the flower spikes (which are long and slender) are produced from the base of the last made pseudo-bulb, and the flower at its apex, one following the other in succession for several years.

[We are indebted to the Right Hon. Joseph Chamberlain, M.P., for his consent to reproduce, with Mr. Burberry's aid, a selection from his orchids.—EDS.]

A GEOGRAPHICAL DESCRIPTION OF THE BRITISH ISLANDS.

By HUGH ROBERT MILL, D.Sc., F.R.S.E.

A SUGGESTION put forward in my paper in the January Number of KNOWLEDGE, on "Geography as a Science in England," that a complete geographical account of the British Islands might be compiled on the basis of the Ordnance Survey maps, has been received with considerable favour. It may not be out of place to summarize here the developments which have occurred, and to re-state the plan with the greater precision that lapse of time, the accumulation of fresh information, and the kindly criticism of friends have made possible.

I must, in the first instance, accord to Mr. J. Logan Lobley the credit of priority, not only in suggesting a complete scheme for the geographical description of the country, but in actually preparing such an account of a representative county. I was unaware of his labours in this direction when I brought forward my scheme and when I wrote a note on the subject in the March Number of KNOWLEDGE, and I am glad now to call attention to his excellent MS. account of the parishes of the county of Surrey, a work which I hope will soon be brought before the public. Mr. Lobley's work is on a somewhat larger scale than I would propose for use in the uniform treatment of the whole country, and it is in some respects treated from a different standpoint. But as work actually done it is of great value, and shows that the advantages of such descriptions had appealed very strongly to practical geologists. Prof. Seeley has also brought to my notice the fact that he has studied the country near London with his students for many years, and has in preparation a description of part of it from the point of view of physical geography. I dare say these are not the only instances of such work having been initiated; the more cases of the kind that have occurred, the more clearly does the importance of a general realization of the scheme appear.

The statement of a possible scheme submitted to the Royal Geographical Society on March 6th, and published in the *Geographical Journal* for April, 1896, may be repeated here in the hope that the range of criticism and suggestion may thus be extended.

THE CHIEF SOURCES OF INFORMATION.

(*a*) The basis of the description should be the topographical map of the Ordnance Survey on the scale of 1 : 63,360, or one inch to one mile. This, including the new survey of England, will be complete before the close of the present century. The sheets, measuring eighteen inches by twelve, contain two hundred and sixteen square miles of surface for England and Ireland; but the sheets for Scotland measure twenty-four inches by eighteen, and contain four hundred and thirty-two square miles. The map is in two editions, showing relief by hachuring and contouring respectively, and all sheets are graduated on the edge to single minutes of latitude and longitude, with subdivisions to ten seconds. In special cases the maps on the scale of 1 : 10,560, or six inches to one mile, would be referred to.

(*b*) The maps of the Geological Survey on the same scales supply in many cases the geological reasons for geographical conditions, and the memoirs to the various sheets, or on selected districts, usually give valuable summaries of the physical geography from the geological standpoint.

(*c*) The charts of the Hydrographic Department supply full details as to sea-depths along the coast, and as to depths of navigable rivers and a few lakes.

(*d*) The publications of the Meteorological Office, of the two Meteorological Societies, and of Mr. Symons (for rainfall), contain a great amount of information as to the climate of the British Isles.

(*e*) The Census reports give full particulars of the population of each registration district and of their occupations, a matter of great geographical importance; although I am not aware that the distributional relations of the Census have ever been fully worked out in the manner adopted, for example, by the United States Census Office.

(*f*) The reports of births, marriages, and deaths supplement the Census returns in many ways, and contain materials for statistical maps, including maps of the distribution of diseases as worked out by Dr. Havilland for the Lake District.

(*g*) The Board of Trade and other Government departments publish full accounts of exports, imports, and of internal transport, of mineral and agricultural produce and manufactures, all of which are capable of geographical treatment.

(*h*) The publications of such societies as the Royal Agricultural, the Archæological, the Statistical, the Institution of Civil Engineers, and many others, contain papers on subjects which may be profitably consulted; and there are numerous county histories and books on special aspects of geography from which help may be obtained.

(*i*) There are now several amateur photographic societies which make systematic collections of characteristic pictures of their own neighbourhood, such as that over which Sir Benjamin Stone presides in Warwickshire. Numerous local scientific societies are rendered accessible and capable of acting in concert through a committee of the British Association, many of the members of which are willing to act as skilled collectors of information.

THE PLAN OF THE MEMOIR.

Taking the one-inch map as a basis, the discussion and treatment would be on a corresponding scale. No doubt, by enlarging on each of the heads to be mentioned, a treatise of great length might easily be compiled for each sheet. My proposal is to aim at conciseness: as far as possible to touch only on essential matters, and to treat these exclusively from the geographical standpoint. A good deal of repetition would be avoided by the preparation of

an introductory memoir describing the general features of Ordnance maps, explaining scales, the use of contour-lines, and map reading generally. This should also contain a statement of the principles of geography as applied to regional descriptions. The suggested memoir for each sheet would include :—

(*a*) *Index* of all names on the sheet, referring to them by latitude and longitude in areas of one minute by one minute, giving also the altitude (exact or approximate) in the case of hills, river sources, towns, villages, houses, etc., and the length of streams or portions of streams included.

(*b*) *Place-names.*—Notes on such of the place-names as present features of geographical interest.

(*c*) *Mean Elevation* of the sheet, with the areas between successive contour-lines, and statement of maximum and minimum heights.

(*d*) *Hypsographical Description.*—A general statement of the elevations and depressions of the sheet, mentioning their relation to the larger features of the country. Length of streams and their drainage areas.

(*e*) *Physiographical Explanation* with reference to the type of land-form in relation to geological structure, the position of the surface in the cycle of geographical development, the character of the soils and mineral productions, the local magnetic conditions, and the conditions of climate so far as these are dependent on position and configuration.

(*f*) *Vegetation and Agriculture.*—The approximate areas of woodland, moorland, pasture, arable land, and the leading crops. Local floras and faunas.

(*g*) *Political and Historical.*—The parish, county, and municipal boundaries. Historical sites, and events which depend on geographical conditions.

(*h*) *Geographical Description*, showing the relation of the human inhabitants to all the foregoing conditions, especially with regard to the sites of towns and villages, the distribution of population, the utilization of natural resources, and historical development of industries. Local vocabularies.

(*i*) *Illustrations.*—A few carefully selected photographs of typical scenery should accompany each sheet. Some sketch-maps and diagrams might also be included.

(*k*) *Bibliography*, giving titles of works relating to places contained in the sheet.

Several matters of very great importance cannot be included, because the facts to be ascertained would involve special surveys, *e.g.*, the variation of the force of gravity ; the seismic conditions ; hydrographic conditions involving the volume, speed, and normal seasonal fluctuations of all rivers—a subject which will acquire great economic importance in a few years ; and the ethnological description of the people.

PROPOSED METHOD OF EXECUTION.

(*a*) *Index.*—This requires simple mechanical compilation. It would vary greatly in length, some sheets having less than fifty names, others probably more than one thousand.

(*b*) *Place-names.*—The notes would be limited to (1) alternative names for places mentioned in the sheet, (2) corrections of spelling, (3) critical discussion of such place-names as are descriptive of geographical forms or positions, (4) discussion of names which can be traced by historical records sufficiently far back to throw light on prehistoric populations. The necessary information would be obtained from topographical and archæological works, from dictionaries of place-names, and from local students ; but the lists would require very careful editing by an expert, and must be strictly limited to cases concerning which there is no reasonable doubt.

(*c*) *Mean Elevation.* — The area between successive contour-lines on the map must be measured by the planimeter or by squared tracing paper, and the volume deduced by considering the mean inclination of the successive surfaces, which would also give the true area of the country as contrasted with the area projected on the plane of sea-level given on the map. The distortion due to the conical projection on which the map is drawn will probably be too insignificant to require notice ; if not, it must be allowed for. Check estimates might be made by Heiderich's method of drawing numerous equidistant profiles, and calculating the contents by Simpson's formula ; and also by marking as many actual elevations as possible on the map, and combining the arithmetical averages of each square inch, as in Karsten's method of estimating ocean depths. This work demands a considerable amount of skill and attention. It would be very suitable as an exercise and training for students, if any institution existed in this country where students could be induced to study geography seriously.

(*d*) *The Hypsographical Description* would in most cases be very brief. It should be written from the map, considering both hachures and contour-lines, and afterwards verified on the ground. The lengths of parts of rivers and their drainage areas would be treated in this description.

(*e*) *The Physiographical Explanation* would, so far as the geology is concerned, be simply a restatement of the "Physical Geography" section of the Geological Survey memoir, with such modifications as the modern views of the cycle of development of a land surface suggest. The character of the soils would, to a certain extent, be derived from the drift-maps of the Geological Survey, from notes of official or private geologists, and in some cases from local inquiries. The mineral productions would be described from the official returns. Climatic data would be derived from the publications of the Meteorological Office and of societies, supplemented in many cases by local information.

(*f*) *Vegetation and Agriculture.*—The areas of forests, parks, and moorland or commons would be measured on the six-inch Ordnance Survey maps, on which a distinction between different kinds of wood is made. The agricultural information would be got from official returns, the transactions of agricultural societies, and local inquiries ; while a knowledge of any peculiarities of local flora and fauna would be similarly obtained.

(*g*) *Political and Historical.*—The boundaries would be taken as shown on the map, referring to any important changes, such as the reports of Boundary Commissioners. Historical information would be sought from historical and archæological societies, and would be very stringently edited, so as to confine it strictly to those features and events of direct geographical importance.

(*h*) *The Geographical Description* would be the most important part of the memoir, and must be the work of a trained geographer, who, after studying the maps in the light of all the information referred to above, shall have made himself familiar with the ground. It would deal directly with the relation of the people to the land, showing the control exerted by geographical conditions on the sites of towns, on dwellings, occupations, the distribution of the people, the lines of communication, and, if data are forthcoming, on local character. Historical changes in the resources and industries of a region would be considered, to show in what degree they occurred in consequence of geographical changes, *e.g.*, the silting up of harbours, the destruction of forests, the discovery or exhaustion of minerals ; or in what degree they

occurred in spite of geographical conditions, *e.g.*, the establishment of a gunpowder factory in an agricultural district, or the tunnelling of a hill by a new railway. Many of the more interesting relations to be discussed in this description are undergoing change, and unless they are soon studied and recorded the value of the work will be much reduced.

(*i*) *Illustrations.*—A sketch-map on the scale of, say, ten miles to the inch would be given, showing the area of nine sheets of the one-inch map, including the eight sheets which touch the sheet under consideration. A small index map on the outside cover could show the sheets contained in the whole country (England, Scotland, or Ireland, as the case might be). One or two characteristic profiles on a natural scale might be given, and a selection of views of characteristic scenery taken from a carefully chosen standpoint. It might be found possible in a few cases to give characteristic type-portraits of the people, and illustrations of the leading industries of the district.

(*k*) *Bibliography.*—All the books, articles, or references dealing with places referred to in the sheet would be recorded, so that a student could at once refer to all available original sources.

PROBABLE MAGNITUDE, DURATION, AND UTILITY OF THE SUGGESTED WORK.

The land area of the British Islands, excluding the Channel Isles, is estimated at one hundred and twenty thousand nine hundred and four square miles, which would correspond to five hundred and sixty sheets containing two hundred and sixteen square miles each, the size of the English one-inch sheets. On account of the irregularities of coast-line, the one-inch map of England contains three hundred and sixty sheets, that of Ireland two hundred and five sheets, and that of Scotland one hundred and thirty-one sheets of double size, corresponding to two hundred and sixty-two. The total number is thus equivalent to eight hundred and twenty-seven sheets of the usual size (eighteen inches by twelve); but of these twenty-seven at least are, so far as one can judge from the index maps, entirely blank, leaving eight hundred which would have to be considered. Of the eight hundred there are at least two hundred and fifty-eight which contain less than half their area of land surface. However, it seems to me that the advantages of having the memoirs in the form of a pamphlet corresponding to each sheet, and numbered in the same way, would be sufficient to make it worth while to face the prospect of eight hundred separate booklets. There might, in fact, be rather more, as the special sheets combined out of several to show the environs of important towns would naturally be included. The little books would be partly statistical and partly descriptive, and their aim would be to present the information in the most concise and systematic form. Possibly, wherever a sheet contained less than a certain area—say fifty square miles—of land, it would be found convenient to reckon it as part of its next neighbour. If the memoirs were printed in royal octavo form, the size of each might vary from eight to thirty-two, or possibly, in rare cases, to forty-eight pages. This is little more than a guess, but it illustrates the scale on which I think the work should be undertaken. The average length might be about twenty-four pages, which would give nineteen thousand two hundred pages for the whole work; this would correspond to twenty volumes of nine hundred and sixty pages. If the work were undertaken with a sufficient staff to turn out an average number of forty memoirs in a year, it would require twenty years for its completion; an increased staff would allow of the work being more quickly completed.

At the meeting when this scheme was discussed general approval of the principle was expressed by such authorities as General Sir Charles W. Wilson, late Director-General of the Ordnance Survey; Colonel J. Farquharson, the present Director-General; Mr. Clements R. Markham, President of the Royal Geographical Society; Mr H. J. Mackinder, Reader in Geography at the University of Oxford; Mr. E. G. Ravenstein; and Sir Benjamin Stone, M.P. There was, however, considerable divergence of opinion as to the proper unit of description, the majority considering that a political unit—the parish, hundred, or county—ought to be adopted.

The advantages of the map-sheet as a unit still outweigh those of the parish or county, in my mind, for a work on the scale and with the object that I have proposed. Once the description of the country is complete on the rigidly uniform plan suggested, it would be a very easy matter to prepare a series of county memoirs each of which could be worked up from the special point of view most important in the individual case.

The council of the Royal Geographical Society has appointed a committee to consider the practicability of undertaking the description of a specimen area as a sample of the whole and as a test of the character of the projected work. The complete work would prove very expensive for any private society, and from its national importance should, if undertaken at all, be carried out at the cost of the nation, under such expert supervision as would ensure continuity and steady progress. Whether this could be best attained by entrusting the work to the organization of the Ordnance Survey or to the Royal Geographical Society, or to a special Government department for geographical work, is a question that might be very profitably discussed. A geographical department would be a very useful adjunct to the scientific equipment of the Government, and could be utilized in many ways, not the least important being the co-ordination of the geographical data already copiously collected by Government departments, the work of which at present remains isolated and unprofitable.

PROTECTIVE RESEMBLANCE IN THE NESTS AND EGGS OF BIRDS.

By HARRY F. WITHERBY.

IN a former article* a few cases of protective resemblance in birds were dealt with, and the accompanying illustrations furnish us with two further examples of the subject. Both engravings are from beautiful photographs by Mr. G. W. Burn Murdoch. The one of a long-tailed tit's nest is an excellent example of protective resemblance in the nest of a bird, while that of the oyster catcher's eggs is a good illustration of the subject in the eggs of a bird.

The long-tailed tit's nest is particularly difficult to distinguish from its surroundings, even in the photograph, where only the immediate surroundings are taken in. It may be well to briefly describe the builder of the nest before we go on to the nest itself.

The long-tailed tit (*Acredula caudata*) is a member of the family *Paridæ*, which contains some of our smallest and at the same time best-known birds, which may be classed amongst the happiest and most lively. The long-tailed tit is in reality a very tiny bird, although its tail, which is longer than its body, gives it the appearance of being larger than it really is. The bird

* *See* KNOWLEDGE, March, 1896.

is a resident and fairly common in the British Islands. Perhaps the most interesting point in its life history is in

Fig. 1.—Nest of a Long-tailed Tit in a Gorse Bush.

connection with the nest, which takes a fortnight to build and is a perfect work of art. In shape it is similar to that of a wren, being long and oval with a small hole in the side near the top.

This curious shaped nest has given to its maker the name of bottle-tit, and when the bird is sitting inside its long tail is turned over its back, and often protrudes from the entrance hole. The nest is made of moss and lichens, woven and cemented together with spiders' webs. The outside generally resembles its surroundings closely; when in a lichen-covered bush or tree it is often covered with silvery lichens, while, should the tree be mossy, the nest, too, is often mossy.

The bird does not, however, seem to understand to the full the protective advantages of this plan, for one found in a green holly bush was covered with white lichens, and was thus much more conspicuous than if it had been made entirely of green moss. Many species are noted for making their nests of materials akin to the surroundings; but one may always find exceptions where the bird has erred and the wrong material has been used.

The nest shown in the illustration was built in a furze bush and was covered with lichen. A few feathers can be seen peeping out of the entrance hole; this may be observed in almost every nest of a long-tailed tit, since the birds always line—or rather fill—the nest with feathers, and even add feathers after they have laid eggs. This, indeed, is very necessary to keep the eggs warm, for they are so numerous that they are one on the top of the other, and the tiny bird cannot possibly cover them all.

The oyster catcher (*Hæmatopus ostralegus*), the eggs of which are figured in the second illustration, is a widely different bird from the one with which we have just been dealing.

It inhabits our seashores all the year round in considerable numbers; in winter in flocks, while in summer it breeds more or less in small colonies. Although the eggs in the present case are a very good example of our subject, yet the breeding habits of the bird as a whole are not altogether consistent with protective resemblance. When the eggs are laid in a scoop in the sand or shingle they very closely resemble their surroundings both in ground colour, marking, and form. They are naturally difficult to find, too, in this position, and more especially because the bird makes a number of sham scoops round the tenanted one, presumably to mislead the ignorant. But the eggs are often laid in a shallow hollow in the rocks or in a scoop in the grass, and when this is the case they are comparatively as conspicuous as they are hidden when in the shingle. The reason for this curious change of habit is not quite apparent. It cannot be—at all events not in all cases—for want of shingle or sand in the locality, for they have often been found placed in the rocks when plenty of suitable shingle was available within a few yards. The shingle would seem to be their natural and original nesting place, not only because of the colour of the eggs, but because the birds always place stones, shells, or some such hard particles beneath the eggs when they are laid on rock or grass.

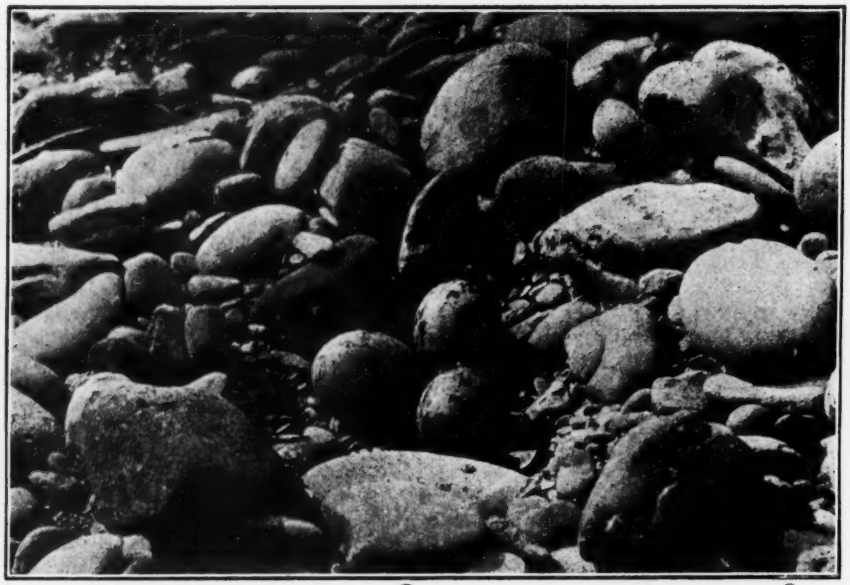


Fig. 2.—Eggs of an Oyster Catcher amongst Stones.

This, indeed, is one of the curious and seemingly contradictory facts with which nature abounds, and we cannot attempt a reason for it.

SUN-SYMBOLS IN ANCIENT EGYPT.

By F. W. READ.

AMONG all the objects worshipped by the Egyptians the sun was the most honoured. It was he who furnished the type of the immortality of the human soul: as he sank daily behind the Libyan Hills and rose again daily over the Arabian Desert, so man, his creature, did not come to an end when he too passed westward to his grave in those same hills, but would rise again with the sun, his lord. To come forth by day, to triumph with the sun, is the object, again and again set forth, of the wonderful collection of religious writings called "The Book of the Dead." But the daily journey of the sun also gave rise to another kind of symbolism. Passing in triumph over the earth, he is its king; and to the pious Egyptian the Pharaoh was his representative, bearing all his titles, clothed with all his attributes, wielding all his powers. One of the titles of the Pharaoh was "Son of the Sun"; another was "Horus," and Horus was before all things a sun-god. On the beautiful statue of Khafra, the pyramid builder (about B.C. 3700), one of the oldest works of Egyptian art, the Hawk of Horus stands behind the king's head, spreading its protecting wings.

Although, in common with the moderns, the Egyptians sang the golden glories of the sun, the one thing that impressed them above all others was the fact that, wherever he went, he divided that over and through which he passed into two parts—the north and the south. When viewed in this light, heaven is "the two heavens," earth is "the two earths," and the space beneath the earth is "the double divine under-world," or "the double hall of Maat." The explanation of these phrases is to be found only in the fact of the sun's daily passage over all countries. As he passes over them he divides each into two, and therefore every country and every nome could be spoken of as "the two earths." Of course, Egypt among the rest might be described in this way, and it is possible that the expression sometimes has a double significance; but there is evidence that, down to the time of the Ptolemies at any rate, the distinction between "the two Egypts" and "the two earths" was well recognized by the learned class.

The pyramid texts, of which the first was discovered in 1880, and only recently published by Maspero, throw much light on this question, as they do upon nearly the whole of Egyptian mythology. In the pyramid built for King Teta (about B.C. 3300) we read: "Teta comes to the two heavens, Teta arrives at the two earths; Teta treads upon the herbage growing under the feet of Seb, he traverses the roads of Nut." The first part of this passage ought of itself to be sufficient to settle the meaning of the phrase "the two earths," since it occurs in connection with "the two heavens," and, obviously, "the two heavens of Egypt" would be absurd. But the second part takes us farther still; from it we see that the two heavens are equivalent to the goddess Nut (the sky), and the two earths to the god Seb (the earth).

This doctrine of duality, which has been briefly indicated, found expression in many ways, but chiefly in the titles of the king. The word "king" itself is expressed in Egyptian by *seten nat*, which, fully translated, means "king of the south and king of the north." Another common title, parallel with *seten nat*, is "lord of the two earths." The parallelism, indeed, is curiously exact, for, just as one could use "two earths" and "earth" interchangeably, so one could express the idea of king by either *seten* or *nat*—preferably the former, which from various causes acquired a pre-eminence.

A consideration of the other symbols of the same doctrine will take us a little deeper into the regions of mythology. Those who only know Horus and Set from the writings of Plutarch and his copyists will be surprised to learn that one of the most ancient titles of the Egyptian king is "the Horus and the Set." According to Plutarch, Typhon (Set) slays his brother Osiris, and Horus, the son of Osiris and Isis, defeats Set and reigns in his father's place. That some such story as this was told in Egypt during the Ptolemaic and Roman periods is highly probable, and some parts of it are demonstrably very ancient. At an early period we hear of a desperate fight between Horus and Set, but it does not seem to have had originally any connection with Osiris; and the combatants are at other times spoken of as friends and colleagues, and not at all as the deadly enemies described by Plutarch The king, as we have said, is called "the Horus and the Set," and sometimes the "Golden Horus and the Golden Set"; he is depicted standing between the two gods, who sometimes purify him with water, sometimes pour the symbols of life and power over him, sometimes instruct him in the use of arms. The two gods are spoken of as brothers having sovereignty over the two divisions of the earth; and that they are identical in character is proved by the use of the expression "the two Horus gods" as the equivalent of Horus and Set. The famous queen Hatshepsu (about B.C. 1600) says on her great obelisk at Karnak: "I bear the white crown (of the south), I am diademed with the red crown (of the north); the two Horus gods have united for me their divisions; I rule this earth like the son of Isis (*i.e.*, Horus), I am victorious like the son of Nut (*i.e.*, Set)." It will be seen that there are here three phrases in parallelism: first, the white and the red crowns; second, the two Horus gods; and, third, Horus and Set. The inscriptions known as "The Book of Hades," relating to the progress of the sun through the under-world during the night, contain two representations of a god with two heads, those of Horus and Set, who is called "the double-headed." In one case he stands on two bows (evidently another of the many symbols of north and south), and the text says: "The two bows bear the double-headed in his mystery; they direct Ra to the eastern horizon of heaven and they advance on high with him." Here we find Horus and Set not only conjoined in one person but actually identified with Ra (the sun-god), proceeding towards the eastern horizon of heaven and advancing on high. These and other texts point to the true interpretation of our pair of gods: they symbolize the northern and southern aspects of the sun and his dual sovereignty.

A much-damaged inscription which came from the ancient temple of Memphis, and which purports to have been copied from an older original by order of Shabaka, an Ethiopian king of Egypt (about B.C. 700), tells us of a fight between Horus and Set, which was brought to an end through the mediation of Seb, chief of the gods. Seb declared that there should be an arbitration between the belligerents, and summoned them to a mountain in the desert to the east of Memphis; each stood upon a hillock and there made peace, declaring the nome of An in which they stood to be the boundary of their territories. Seb then ratified the arrangement, and appointed Horus king of the north and Set king of the south. In this there is no allusion to the cause of the combat—no suggestion

that Osiris had been slain; and it seems almost certain that the scribe who wrote the account to adorn the walls of the great Memphite temple was unacquainted with the legend of the enmity between Osiris and his brother Set, especially as the death of Osiris is mentioned in another connection in the same inscription. It may also be noted that the pyramid texts, though they speak continually of all three gods, and even occasionally refer to the contest between Horus and Set, never suggest that it was connected with the death of Osiris. We must conclude, then, that the Osirian myth, in the form in which Plutarch gives it, does not belong to the early ages of Egyptian history. Rather was the death of Osiris quite independent of the contest between the two Rehus (the name given by the Egyptians to a pair of gods, such as Horus and Set, Shu and Tefnut, Ra and Tehuti). It is not difficult to understand, however, how, in the process of amalgamation by which the Egyptian Pantheon was formed, the two myths would tend to coalesce and ultimately become fused. But that the new doctrine never altogether ousted the old is curiously illustrated by the position of Isis and Nephthys. Isis was the wife of Osiris, and Nephthys that of Set, and they ought, one would suppose, to be in antagonism; nevertheless, throughout Egyptian history they are the two beloved sisters who stand beside Osiris—the two weepers who mourn his death, and that of the dead man identified with him. This conception is clearly a survival of a much older mythology than that which the Greeks and Romans found in Egypt.

Fig. 1.—In the centre is the King Her-Hor; on the right of the picture are Nekhebit wearing the southern crown, and Horus offering the same emblem to the king; on the left are Uatchit and Set, respectively wearing and offering to the king the northern crown; over the king is the sun with the two snakes representing the sovereignty of the north and south.

How, then, shall we explain the fight? The most probable suggestion appears to be that it was invented to account for the divided sovereignty. When the "disease of language," mythology, had personified the two aspects of the sun, it was inevitable that stories should arise of how the double kingdom came into being. A fight, followed by the intervention of the great god Seb (or Tehuti, according to another version), and a division of the territory between the combatants, would at once commend itself to the good sense of the early Egyptian. Be that as it may: that the two gods did symbolize for many ages the sovereignty over the north and south is established beyond reasonable doubt. Later on, the antagonism which was originally represented as a mere fight for territory came to be regarded as an allegory of the eternal war between light and darkness, between the Nile and the desert, and even between good and evil. This last stage, which is supposed to have been arrived at under the influence of Persian ideas, was marked by the erasure of the name of Set from the monuments, and the substitution of other names for his in the religious papyri.

The duality of the Pharaoh's kingdom is expressed also by the two goddesses Nekhebit and Uatchit, who are represented usually by a vulture and a uræus, but sometimes by two vultures, sometimes by two uræi, sometimes by snake-headed vultures, and sometimes by winged snakes. From their continually receiving the same epithets as the southern and northern crowns (notably that of "mighty one of magical spells"), and also interchanging with the crowns in different copies of the same text, it seems reasonable to infer that they are in fact the crowns personified. Although this may be open to question, it is clear that Nekhebit and Uatchit are goddesses of the south and north. They usually wear the special crowns of their respective territories, they are represented standing on the plants emblematic of the two divisions, they are constantly depicted in close association with the two snakes depending from either side of the sun (who sometimes even bear their names), and they are also found in company with Horus and Set. One piece of sculpture seems to sum up the whole matter very effectively: the king is shown seated between the goddesses Nekhebit and Uatchit, each wearing her appropriate crown; beyond them, on either side, stand Horus and Set offering the two crowns to the king; beyond these again are written the speeches of the gods in making the presentation, and above is the sun's disc with the two uræi (*see* Fig. 1).

Here we must close this too brief sketch of the myths and symbols that gathered round the sun, and the Pharaoh as his image upon earth. To exhaust the subject would be well-nigh impossible, for, to the Egyptian, the sun was the one grand object of worship—the creator and sustainer of the universe; and concerning him, in his various personifications, myths innumerable were related.

THE ROYAL SOCIETY OF PAINTERS IN WATER COLOURS.

IT is to be noticed as a curious fact that in this exhibition the majority of the more important pictures are the work of artists well known to fame as painters in oil, illustrators, or designers; and to students particularly this fact would seem to be of some interest. Judging from the pictures themselves it is extremely difficult to find a satisfactory reason for this superiority on the part of those who have not made water-colour painting their specialty, for where this superiority

is not maintained by a more ideal conception or truthful rendering of nature, it is to be found in the more prosaic qualities of technical skill.

On entering the gallery the attention is immediately arrested by Mr. J. M. Swan's "Jaguar and Macaw," in which we find a strength and freedom of colouring rarely attempted by one who makes water his only medium. Mr. George Clausen's "Tired Mower" is one of the most admired pictures here; yet the technique is poor, and the figure, though well drawn, is leaning on the scythe in an impossible manner. Mr. Clausen would certainly not have fallen into this error had he included modelling in his studies. Mr. Ernest A. Waterlow's little sketches are unsurpassed as truthful copies of nature; look, for instance, at "The Fields in June," a very lovely bit of sunlit meadows. In "Racing Nymphs," Mr. Weguelin gives us a delightful conception, in which fancy, draughtsmanship, and technical skill combine with equal merit. The works of Miss Clara Montalba, despite the repeated trick of composition and colour, are attractive beyond most of their compeers. The exhibits of Mr. Herkomer, Sir John Gilbert, Mr. Macbeth, Mr. David Murray, and Mr. E. J. Poynter, all hold a high place in this year's exhibition; and the same may be said of those sent by less well-known painters in oil. Mr. Walter Crane, one of our greatest cosmopolitans in the art world, sends one picture—"Britomart." Here, in places, we find the drawing weak, the modelling weaker, and the colouring none too pleasing; but behind all is the personality of Mr. Crane, with such a strength of conception and depth of artistic feeling, bred of wide sympathies, that the picture is one of the most striking and interesting in the gallery. Mr. Abbey—whose illustrations find the most devoted admirers in the old and new world—also sends one picture: a daring bit of composition, overstepping, in many ways, and with the best of results, the traditional bounds within which the water-colour school has found all possible requirements for the making of a good picture.

The exhibits of Mr. Carl Haag, Mr. R. Thorne Waite, Mr. W. Callow, Mr. E. Walker, and others, are, in many cases, equal in merit to those we notice above; but still the honours are held by those who have made their mark in some other branch of the kindred arts. And as to the reason of this? It is not stating the case fairly to say that the superior talent displayed is only what might be expected from artists of well-known high capabilities, for were not these same capabilities obtained, at least partly, by variations of the method of study? The greater understanding of his own language comes to him who is most intimately acquainted with that of others; and, similarly, the colourist can bring to bear on his canvas that knowledge which he can obtain only by his efforts on paper, and *vice versâ*.

We fear the general impression to be gathered from the above is the superiority of oils as a medium for the student; but we must point out that Turner and others used water for their closer studies, and found oil the better medium for the expression of their ideal. We might carry these inquiries into the other branches of the arts, and with less satisfactory results, for the more mechanical and less ideal the art, the more we find on the part of the workman a tendency to specialization.

Science Notes.

M. LIPPMANN has given a very interesting account of his experiments on colour photography before the Royal Society, and last month he also gave a discourse on the subject at the Royal Institution. He exhibited the pictures in natural colours which he has obtained, the vivid character of the tints being very striking. His earliest attempts were photographs of stained-glass windows, and his later work includes pictures of flowers, and landscapes showing the tints of brickwork and stonework, the green colour of leaves, etc. The method depends in principle on obtaining stationary light-vibrations in a sensitive film by means of a metallic mirror of mercury placed behind it. An interesting illustration of the length of waves of light was given by M. Lippmann in his lecture at the Royal Institution, when he stated that five hundred of the stationary waves of light, arranged in succession, can exist in a film of the thickness of ordinary note-paper. The dimensions involved may be realized by imagining a building of five hundred storeys, the height from base to roof, with its successive tiers, being comprised within the thickness of a sheet of paper.

Observations made by M. Perrotin on Mount Mounier, at an elevation of about nine thousand feet above the sea, have convinced him that the period of the rotation of the planet Venus is equal to that of her revolution round the sun, the time of both being two hundred and twenty-five days or less. The observations were carried out in December of last year, and in February, 1896.

"Ashtonian," writing from Ashton-under-Lyne, wishes to know (1) why the honey and pollen of poisonous plants like the foxglove are not detrimental to bees visiting the flowers; and, also, (2) the reason for certain of the ray florets of the daisy being tinged with red, while the rest are white.

(1) The nectar of a number of plants is poisonous—a quality shared also, no doubt, by their pollen. The principal constituent of honey is grape sugar; pollen grains can usually be detected in honey, and small quantities of other substances are present to which are due the peculiar colour, flavour, or fragrance by which special kinds of honey are distinguished. These substances sometimes impart narcotic or other deleterious qualities. Bees frequently fall out of gladiolus flowers in a state of helpless intoxication, and are therefore susceptible; but as the greater portion of the honey and pollen gathered by a bee is disgorged but little altered into the cells of the comb, only a small proportion of the poisonous principle can in most cases be absorbed into the insect's system. As, however, the larvæ are fed on honey and pollen, it is almost certain that bees must to some extent possess an immunity against poisons of this class.

(2) There appears to be a law of progressive colouration traceable in flowers, from the primitive yellow of the simpler blossoms through white, red, and purple to the deep blue of the highly specialized types. Most flowers are capable of reverting to the more primitive colours through which the species may be supposed to have passed in the course of its evolution, but they are apparently unable to give rise to an entirely new colour belonging to a stage of development to which the family has not yet attained. In the case of the daisy it is difficult to say whether the red at the tip of the ray florets is a new or a primitive colour due to reversion; the circumstance that the red appears at the extremities of the petals favours the view that it marks a new departure in the colouration of the species, for, as a rule, new colours appear at the outside, reversion tints at the centre of the blossom. But by cultivation the white ray florets may be converted into red, as in one variety of the garden daisy; and this fact accords fully better, perhaps, with the theory of retrogression. On this view the red tinge represents what once was the colour of the ligulate florets. Increase of light in many instances is known to intensify the colour of flowers.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

MIRA CETI.

To the Editors of KNOWLEDGE.

SIRS,—A maximum of ο Ceti, Mira, was predicted (*Companion to the Observatory*) for 1895, December 9th. But as its minimum occurred in October a search for it was not begun until late in November. Using a Lemaire field-glass of twenty-four lines, I succeeded in finding it definitely, December 6th, and thenceforward to date it was followed up assiduously without the loss of a single night upon which an observation of fair value could be obtained. The season has been unfavourable for such work, not only in this latitude but elsewhere throughout the States. The following estimates are the results of my best endeavours:—

1895.	Magnitude.	1896.	Magnitude.
December 6th ...	8·2	February 3rd ...	3·7
,, 9th ...	8·1	,, 4th ...	3·8
,, 11th ...	7·8	,, 9th ...	3·6
,, 14th ...	7·6	,, 10th ...	3·6
,, 21st ...	7·4	,, 13th ...	3·6
,, 26th ...	6·4	,, 14th, 15th, 16th	3·5
,, 28th ...	5·8	,, 21st ...	3·7
,, 30th ...	5·2	,, 25th ...	3·7
,, 31st ...	5·1	,, 28th ...	3·8
1896.		,, 29th ...	4·0
January 1st ...	4·9	March 1st ...	4·0
,, 3rd ...	4·7	,, 6th ...	4·1
,, 5th ...	4·5	,, 7th ...	4·3
,, 8th ...	4·0	,, 8th ...	4·2
,, 9th ...	4·1	,, 9th ...	4·3
,, 11th ...	3·9	,, 11th ...	4·4
,, 19th ...	3·5	,, 16th ...	4·6
,, 24th ...	3·7		

These figures show a maximum for February 15th, or a day or two before, and that the star reached this phase some sixty days later than the predicted date, and that its brightness was a magnitude less than the traditional light.

Comparison stars used:—γ Ceti, 3·60 magnitude; α Piscium, 3·9; δ, 4·2; V, 5·06; 66, 5·60; 70, 5·62; 71, 6·55; D, 6·62; H, 7·86; N, 8·12; all in Cetus.

R Leonis was again forty days ahead of the predicted maximum; magnitude only 6·4 January 10th.

DAVID FLANERY.

Memphis, Tenn., U.S.A.
18th March, 1896.

To the Editors of KNOWLEDGE.

SIRS,—On several occasions between the 7th and 26th December last I could just catch a glimpse of Mira Ceti with the naked eye by close watching and oblique vision. On the 29th December it was not thus visible to the naked eye, on account of the bright moonlight. Cloudy weather interrupted observations until January 6th, 1896, when Mira was readily visible to the unaided eye as a fourth magnitude star, being almost exactly equal with δ Ceti, and of a deep orange colour.

On January 10th and 11th it appeared to be a little brighter, and on the 18th I estimated it as but a little less bright than γ Ceti. Cloudy weather intervened until February 7th and 9th, when Mira was about equal with γ Ceti. After this it appeared to gradually decrease, and on February 23rd was about the same magnitude as δ Ceti.

Alta, Iowa, U.S.A., DAVID E. HADDEN.
March 16th, 1896.

SUN HALO.

To the Editors of KNOWLEDGE.

SIRS,—Last year I was with a party going through Palestine and Syria. On Saturday, the 20th of April, we stopped for luncheon at 11.30 A.M. on the plain a few miles outside of Damascus. After luncheon, at mid-day, we were suddenly surprised by a noticeable sight, which was very strange to us, and of which none of us could furnish an explanation; it was a triple rainbow. First, there was a complete rainbow all round the sun, with the usual colours, the red inside; second, to the south there was a partial rainbow, part of a circle, concentric with the circle round the sun, the red inside—this being evidently a reflection from the other; and, thirdly, there was another complete circle, but without the colours of the rainbow—just a broad plain ring, much like a lunar rainbow in appearance, this circle lying to the north, with an inclination to the west, though not quite north-west, its circumference running over the centre of the sun. All three were visible at the same time, and there was no rain. I should be glad to get an explanation of this curious phenomenon, and hope the matter will excite the interest of some readers of KNOWLEDGE. HELIOS.

[With regard to the optical appearance here described, the fact of the bow being *round* the sun, and the additional fact of the red colour being inside, are quite sufficient to determine the phenomenon as a halo; not a rainbow, but a bow generated by the direct transmission of light rays through ice crystals.

The other, *i.e.*, the second imperfect bow, also with red inside, was clearly enough another halo, as it had the sun also for its centre. The fact of the colours being similarly arranged also shows it to be a halo, which commonly has a red or an orange tint inside, with a bluish band *outside*. I take it, for this very reason, to be *not* a reflection, but a fresh halo with originating particles of a different refracting angle, and consequently of a different radius.

The circle resembling a lunar rainbow, which passed through the sun's disc, is, without doubt, a "halo of ninety degrees," an unusual form of halo, which owes its origin to the reflection of light from the pyramidal ends of snow crystals as they hang down towards the earth. A myriad of these, with a bright sun, produce an apparently continuous band which spans the heavens, the sun being in the circumference.—SAMUEL BARBER.]

TIDE OF THE RIVER WYE.

To the Editors of KNOWLEDGE.

SIRS,—Would the October, 1883, tide on the Wye be the result of the Krakatoa eruption? The question only suggested itself to my mind while reading the fascinating paper by Rev. E. Rattenbury Hodges in the December, 1895, Number of KNOWLEDGE. The time distance between the eruption and the tidal rise would be between seven and eight weeks (August 27th to October 17th). Is this about the time the great wave would take to reach our shores? The tide was phenomenal. F. H. WORSLEY-BENISON.

[In reply to Mr. Worsley-Benison's interesting question, I have no hesitation in saying that I cannot consider the Krakatoa eruption to have had anything to do with the high rise of the Wye in October, 1883, which was a *tidal* rise, the time of which, apart from its remoteness from the east side of the Indian Ocean, shows it to have been part of the great tidal wave due to lunar and solar influence.

A seismic wave is one caused by a volcanic eruption; although it may reach coasts at a great distance *if there is no intervening land*, it is non-coincident with the cosmic tidal wave.—J. LOGAN LOBLEY.]

THE APPROACHING TOTAL ECLIPSE OF THE SUN.

By A. FOWLER, F.R.A.S.

TOTAL eclipses of the sun have attracted great attention in all times, and are justly regarded as among the most impressive of natural phenomena. So much has been written in description of them that there are probably few readers who are not familiar with the general features of an eclipse, although, in the words of the late Mr. Hind, "no description could give an idea of its awful grandeur." The vast extension of pearly luminosity, surrounding the almost inky blackness of the moon, is certainly quite unique, and can be likened to nothing else.

On the 9th of August there will be a total eclipse, which will, fortunately, be visible from places comparatively near home, and a large number of British astronomers will take advantage of the splendid facilities offered for making the necessary journey. A few particulars as to the way in

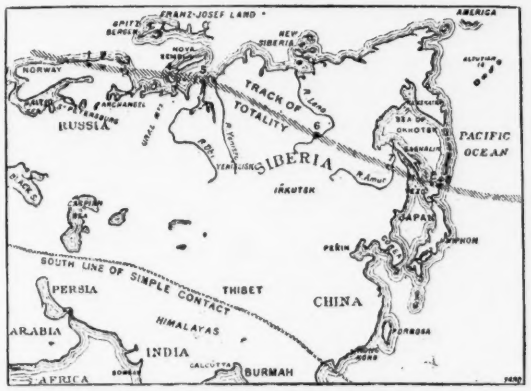


FIG. 1.—Track of Moon's Shadow, August 9th, 1896.

which the eclipse will be utilized by the various observers may, therefore, be of interest at the present time.

The line of central eclipse will pass through the North of Norway, Nova Zembla, Siberia, and Japan, as shown in Fig. 1, for which we are indebted to the editor of the *Journal of the British Astronomical Association*.* In Norway the most favourable station appears to be Vadsö, on the Varanger Fjord, and it is here that the greatest number of observers will await immersion in the moon's shadow. At this point the duration of totality will be about one hundred seconds, with the sun fifteen degrees above the horizon. Astronomically, Japan will furnish the best observing stations, but it is not sufficiently accessible to meet the requirements of many observers. Here totality will last more than two and a half minutes, and the sun will be much higher than in Norway.

Eight stations along the line of totality, indicated by the numbers in Fig. 1, will probably be occupied by various parties of observers.

(1.) Near Bodö there is certain to be a considerable gathering, although the conditions are not favourable to serious work.

(2.) Enontekis, Finland, has been selected by one of the expeditions of the Russian Astronomical Society, and by Prof. Glasenapp and L. G. Vuchikhovsky.

(3.) In the neighbourhood of Vadsö there will be one of the Government expeditions, including Dr. Common, Prof. Lockyer, and the writer; a large section of the British Astronomical Association, headed by Dr. Downing and Mr. Maunder; Dr. Copeland, the Astronomer Royal for Scotland; Sir Robert Ball; Mr. Evershed; M. Antoniadi, from M. Flammarion's observatory; and many others.

(4.) Nova Zembla has been chosen by the Russian Academy of Sciences and the Kazan Society of Naturalists.

(5.) At the mouth of the Obi there will be another section of the Russian Astronomical Society.

(6.) Olekminsk, on the Lena, will be occupied by the chief expedition of the Russian Astronomical Society, and by Prof. Voznesensky of the Irkutsk Meteorological Observatory.

(7.) A station on the Lower Amur has been selected by an expedition from the Pulkowa Observatory.

(8.) In the Island of Yezo, Japan, there will be a British Government expedition, consisting of the Astronomer Royal, Prof. Turner, and Captain Hills, R.E.; a French expedition under M. Deslandres; a party from the Lick Observatory, under Prof. Schaeberle; and another American expedition directed by Prof. Todd.

The duration of a total eclipse is so very brief that the utmost use must be made of every moment. Good organization is accordingly the keynote of success, and to this end a considerable amount of preliminary inquiry and discussion is essential. The arrangements for the Government expeditions have been made by a joint committee of the Royal and Royal Astronomical Societies, which has met at intervals during the last three years. The principal objects to be undertaken are to secure permanent and unbiased photographic records of the corona, and of the spectra of the various parts of the solar surroundings. Such records are considered the first duty of an organized eclipse expedition, but if instruments and observers be available the programme may be extended to include special pieces of research.

At the Japanese station the Astronomer Royal will employ the Thompson photoheliograph of the Royal

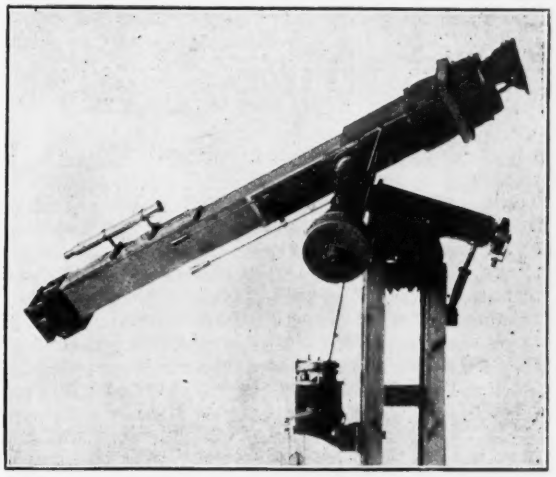


FIG. 2.—Prof. Lockyer's Six-inch Prismatic Camera.

Observatory, giving an image of the sun nearly four inches in diameter. It is not expected that the filmy outlying parts of the corona will be bright enough to impress their images on this large scale; but the very beautiful pictures obtained by Schaeberle in 1893 encourage us to hope that the finer structure of the inner corona will be depicted with almost telescopic minuteness.

* *See Journal B.A.A.*, p. 298.

Professor Turner will use well-tried instruments, which, although yielding pictures on a small scale, will give results strictly comparable in every particular with those of former eclipses. The images will be small and bright, and a special endeavour will be made to register the very delicate regions of the outer corona. One set of pictures will be on a scale of a half-inch to the sun's diameter, and another one and a half inches, the latter being enlarged by a "telephoto" lens.

At the Norwegian station the arrangements for photographing the corona will be in the capable hands of Dr. Common. Part of his outfit will probably consist of a modified Cassegrain reflector, giving large images of the corona; and other instruments which he will employ will give relatively small but bright images similar to those which Prof. Turner hopes to secure in Japan.

During the coming eclipse there will be a new departure in the instrumental arrangements for photographing the corona. In place of the equatorials which have almost invariably been employed up to the present time, the photographic telescopes will be fixed, and will receive the light of the corona after reflection from the mirror of a "cœlostat." The new instrument is an exceedingly portable form of heliostat which has recently been brought to the front by M. Lippmann. It consists simply of a mirror which is made to revolve on a polar axis in its own plane at the rate of one revolution in forty-eight hours, in the same direction as the apparent diurnal motion of the heavens. In a mirror so mounted the image of any celestial object whatever appears stationary, and a telescope pointed at the mirror in any direction will have a constant field of view.

The official observers, however, will not have the photographic field to themselves, although they will naturally have a monopoly of work which can only be done by large instruments. Many members of the British Astronomical party will make use of their cameras and telescopes, and Mr. Lunt will employ the three-inch photographic telescope with which he has been so conspicuously successful in stellar photography. The American observers in Japan will be chiefly occupied in photographing the corona on a large scale with objectives of long focus, and the same method will be adopted by the Russian observers at Olekm'nsk. Several ordinary cameras will be at work at the mouth of the Obi, and at Enontekis clock-driven cameras will be employed.

If the photographs of the corona are as successful as everyone desires, they should throw light on various points of solar physics. The larger pictures should especially enable us to learn something of the solar currents, "lines of force," or whatever it may be that determines the peculiar structure of the solar appendages. The distribution of coronal matter in different solar latitudes should also be revealed, and an investigation of its connection with the sunspot zones will become possible. Another point on which the photographs permit inquiry is the law of decrease in the intensity of the corona in passing outwards. Finally, if success is met with all along the line, it will be possible to determine if the corona changes its form in the interval of about one and a half hours intervening between the observations in Norway and Japan. It may be remarked, however, that previous experience does not favour the idea of such rapid changes.

In addition to the photographic records of the appearance of the corona, there will doubtless be many attempts at sketching. Chief among the workers in this field will be Mr. N. E. Green, a gentleman of high artistic ability, who is well known to the readers of KNOWLEDGE.

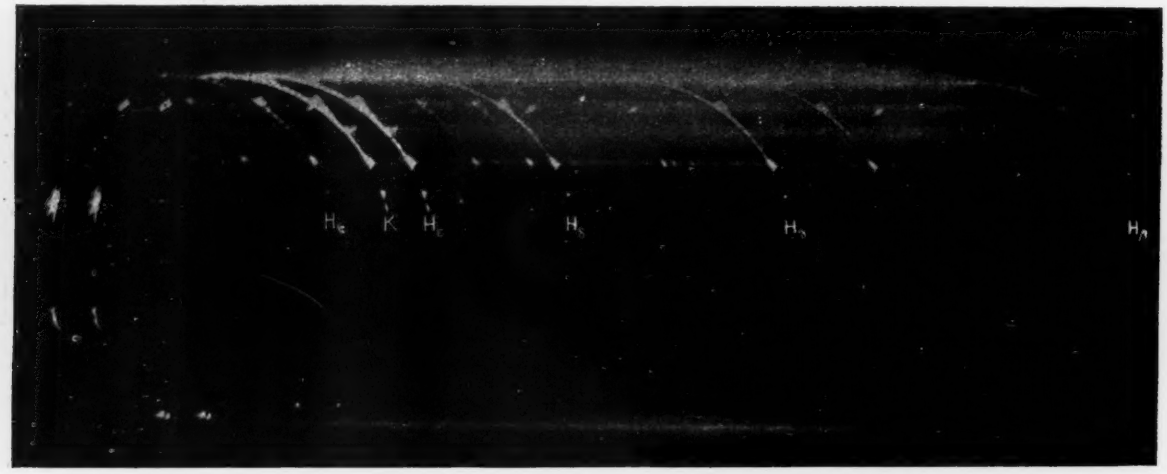


FIG. 3.—Photograph of Eclipsed Sun, April 16th, 1893. Taken with Six-inch Prismatic Camera in West Africa by Mr. Fowler.

We now come to the spectroscopic part of the attack. The spectrum of every prominence, every part of the visible chromosphere, and of as many regions of the corona as possible is to be observed or photographed, in order that the duty of fully recording the phenomena shall be faithfully accomplished. It is true that the chromosphere and prominences can be investigated without an eclipse, but it would be unwise to completely neglect them in the belief that we perceive everything connected with them in our daily observations. At the same time, as the corona cannot yet certainly be observed at all except during an eclipse, and the lower reaches of the chromosphere only very imperfectly, it is to these features that attention will be chiefly directed.

For recording the spectroscopic appearances, instruments of two forms are employed—those which are provided with slits, and those which utilize the eclipsed sun itself as a virtual slit in the form of a ring.

The ordinary slit spectroscope may be used in either of two ways. It may be employed as an integrating spectro-

scope by simply directing the collimator to the moon's centre, or as an analyzing spectroscope by placing the slit in the focal plane of a telescopic objective or condenser. In the first case the spectra of corona, prominences, and chromosphere will all be superposed, so that in the absence of other evidence the spectra of the different parts could not be separated. The use of a condensing lens enables the observer to localize some particular region of the corona upon the slit, and its spectrum may then be studied apart from that of its neighbours.

Spectroscopes without slit or collimator were first employed for eclipse observation by Respighi and Lockyer, in 1871. The principle of this method is very simple. In an ordinary spectroscope the function of the collimating lens is to render parallel the rays proceeding from the slit; and the "lines" which one usually associates with spectra are simply images of the slit. If the ordinary slit be replaced by a circular one the spectrum lines become spectrum rings; indeed, the shape of the slit in all cases is reproduced in the "lines." The rays proceeding from the sun are already parallel, so that a collimating lens is superfluous, and the eclipse itself is at once the source of light and the slit. The eclipsed sun is in reality a number of independent slits: one—a complete ring—corresponding to the corona, and others of irregular form corresponding to the different parts of the chromosphere and prominences. Each "line" in the spectrum of a prominence is represented by a picture of the prominence, and if different vapours are unequally distributed these images will differ.

When the slitless spectroscope is employed for photography it becomes a "prismatic camera," and takes the form of a large prism placed in front of the objective of a photographic telescope. Such an instrument is shown in Fig. 2, and a photograph taken with it in Fig. 3, both of which we owe to the kindness of Prof. Lockyer. As a single exposure gives the spectrum of every part of the solar surroundings, the prismatic camera provides a very complete record of the spectroscopic appearances during an eclipse. For a considerable interval before and after totality the sky illumination is sufficiently reduced to show the chromosphere spectrum near the cusps of the crescent sun, and very valuable photographs may therefore be taken out of totality. Incidentally it turns out that the prismatic camera is the best possible instrument for photographing the solar prominences. This is illustrated in Fig. 4, which is an enlarged view of a group of prominences photographed in K light during the eclipse of 1893.

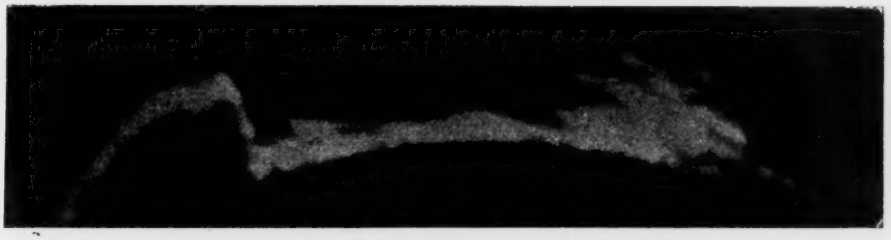


FIG. 4.—Prominences in K Light. Prismatic Camera, 1893.

Captain Hills has provided himself with a very fine slit spectroscope, having four quartz prisms and a condensing lens of four and three-quarter inches aperture, with which he hopes to photograph the spectrum of the corona. The instrument will be fixed on a horizontal base, and the rays of light from the eclipsed sun will be reflected into it by a heliostat of the ordinary form.

In Norway the principal spectroscope to be employed by Prof. Lockyer and the writer is a prismatic camera of six inches aperture, which was very successfully used in Africa in 1893. The instrument is mounted as an equatorial, and the arrangements provide for the exposure of a large number of plates in quick succession. An integrating spectroscope will also be employed by Prof. Lockyer.

We understand that Dr. Copeland will be armed with a prismatic camera, while Mr. Evershed will employ spectroscopes of both forms. The Russian party at Olekminsk will also be provided with a slit spectroscope arranged to photograph the coronal spectrum, and this method will probably be followed by M. Deslandres in Japan.

As the photographic plates cannot yet be relied upon to completely delineate the less refrangible parts of the spectrum under the special circumstances of an eclipse, they will be supplemented by visual observations. Mr. Maunder intends to use a slitless spectroscope to study specially the distribution and extension of the green ring corresponding to 1474 K, and it is hoped that other observers will similarly record the appearances of the yellow line of helium and the red line of hydrogen.

Apart from adding to our scanty knowledge of the undoubted coronal spectrum, and its possible variation from one eclipse to another, one of the chief points on which it is hoped that the spectroscopic work will enlighten us is the location in the sun's atmosphere of the vapours which produce the Fraunhofer lines. There is little doubt that the base of the chromosphere—the so-called "reversing layer"—is rich in bright lines, but the precise relation of these to the dark ones of the Fraunhofer spectrum is by no means understood.

Among the more special investigations which will probably be undertaken one may mention that Dr. Downing will make polariscopic observations, with the view of ascertaining the proportion of reflected to intrinsic light in the corona.

Photometric observations, having for their object the determination of the general brightness of the corona, will probably also be made at some of the observing stations, easy methods for doing this having been suggested by Mr. Maunder and Mr. Lunt. Mr. Crommelin has drawn attention to the desirability of recording the attendant phenomena, such as the mysterious "shadow bands," and some of the observers who have no telescopes will doubtless keep a look-out for such appearances.

The Russian observers at Enontekis will study the relation of the coronal spectrum to that of helium, and there is little doubt that M. Deslandres will endeavour to test the truth of his conclusion from the observations of 1893, that the corona shares in the general solar rotation. Prof. Voznesensky's object during the eclipse will be to investigate the meteorological effects which accompany the temporary obscuration of the sun's light and heat.

From what has been said it is evident that there will be no lack of observers during the forthcoming eclipse, and all friends of science will wish them the utmost success in the various researches undertaken.

PHOTOGRAPH OF THE CLUSTER MESSIER 24 CLYPEI.

By ISAAC ROBERTS, D.Sc., F.R.S.

R.A. 18h. 12m., Decl. S. 18° 28′.

THE photograph covers the region between R.A. 18h. 9m. 15s. and 18h. 16m. 2s. Declination between 17° 49′ and 19° 2′ south.

Scale, one millimètre to twenty-four seconds of arc.

Co-ordinates, for the epoch A.D. 1900, of the fiducial stars marked with dots.

Star (·). D.M. No. 4864. Zone − 18°. R.A., 18h. 9m. 38s. Decl., S. 18° 41·4′. Mag., 6·8.

Star (··). D.M. No. 4886. Zone − 18°. R.A., 18h. 11m. 37·1s. Decl., S. 18° 30·0′. Mag., 6·7.

Star (∴). D.M. No. 4896. Zone − 18°. R.A., 18h. 12m. 51s. Decl., S. 18° 39·6′. Mag., 7·3.

Star (::). D.M. No. 4900. Zone − 18°. R.A., 18h. 12m. 56·4s. Decl., S. 18° 12·5′. Mag., 8·2.

Star (:·:). D.M. No. 4926. Zone − 18°. R.A., 18h. 15m. 28·7s. Decl., S. 18° 54·2′. Mag., 6·0.

The photograph was taken with the 20-inch reflector on August 14th, 1895, between sidereal time 18h. 57m. and 20h. 57m., with an exposure of the plate during two hours.

REFERENCES.

The cluster is N. G. C., No. 6603; G. C., No. 4397; and h 2004.

Sir J. Herschel (G. C., 4397) describes the cluster as remarkable, very rich, very much compressed, round, and the stars of the 15th magnitude.

The photograph shows the cluster to be in shape somewhat resembling a horseshoe, with the open side pointing towards the *north preceding*, and the stars, both in it and in the regions around, are in lines and curves of various form. The stream of the Milky Way is well shown on the photograph, with dark spaces in which are few stars, and in some places none; the brightest star on the plate is only 6·8, and the faintest about 17th magnitude. The white line which is shown on the cluster consists of five or six stars so close together that their photo-images overlap; and on several other parts of the plate where the stars show an elongation, it is due to double or multiple stars.

There are doubtless many of our readers who possess a telescope which is equatorially mounted, and would like to examine visually those parts of the sky where are the marvellous groups and curves of stars which are shown on the annexed as well as on other photographs already published in KNOWLEDGE; and, in order to enable them to point their telescopes upon such objects, the application of the following simple methods will suffice.

Let us suppose that it is desired to determine the co-ordinates (right ascension and declination) of the centre of the small group of stars sixty-six millimètres from the *north* edge and eighty-five millimètres from the *preceding* edge of the photograph annexed; and also to ascertain what would be the diameter of a circle drawn on the photograph that would be equal to the field of view of an observing telescope, which we will assume to be five hundred and fifty-two seconds of arc in diameter?

Two questions are herein involved, and we will answer the second in the first order. The scale of the photograph is, as already stated, twenty-four seconds of arc to one millimètre, and the field of view of the observing telescope five hundred and fifty-two seconds of arc; the measured diameter, in millimètres, of a circle drawn on the photograph will therefore, obviously, be $\frac{552''}{24''} = 23$ millimètres. If we take, between the points of a pair of compasses, the radius 11·5, and with it describe a circle on a piece of paper; then cut out the interior and apply the vacant circle of twenty-three millimètres in diameter to any part of the photograph, it will, approximately, represent the telescopic field of five hundred and fifty-two seconds of arc in diameter; where, within a corresponding coincident area in the sky (if the telescope is of sufficient power to show stars down to about the 17th magnitude), all the stars shown on the photograph would be visible.

The other question—how to determine the co-ordinates of the positions of any star or other object shown on the photograph—will be answered in the following manner:—

First.—How to find the right ascension of the centre of the group of stars referred to above:—

The R.A. of the fiducial star (::) = 18h. 12m. 56·4s.
" " " (··) = 18h. 11m. 37·1s.

0h. 1m. 19·3s. = 79·3s.

(the difference in R.A. between them). We must now convert these 79·3 seconds of time into millimètres for measurement purposes, and that can readily be done by aid of the table annexed, which is computed to show the value of one millimètre, in seconds of time, at each degree in declination between the equator and the poles. The declination of fiducial star (::) is 18° 12·5′ *south*; and by referring to the table we find the value of one millimètre at eighteen degrees from the equator to be 1·68 seconds of time in R.A., and therefore $\frac{79{\cdot}3s.}{1{\cdot}68s.} = 47{\cdot}2$ millimètres. Take this distance between the points of a pair of dividers; place one point on the centre of the fiducial star (::) and extend the other point towards the *preceding* side; at the same time place a rule, having a fine edge, in *north* and *south* direction so as to bisect both fiducial star (··) and the disengaged point of the dividers.

The edge of the rule is then on the meridian (18h. 11m. 37·1s.) of the fiducial star (··); and whilst the rule is firmly held in this position, measure the distance of the centre of the group of stars herein referred to from it, which will be found to be 3·2 millimètres. Then 3·2 × 1·68 = 5·37 seconds of time, being the distance in R.A. of the centre of the group from the meridian of fiducial star (··), and 18h. 11m. 37·1s. + 5·37s. = 18h. 11m. 42·47s. is the required R.A. of the centre of the group.

Second.—To find the declination of the centre of the group:—

The declination of the fiducial star (··) is 18° 30·0′
" " " (::) " 18° 12·5′

0° 17·5′ = 1050″ of arc,

which is the difference in declination between the two stars; and since the scale of the photograph is twenty-four seconds to one millimètre, 1050″ ÷ 24″ = 43·75 millimètres. Take this distance between the points of the dividers, and place one point on the centre of fiducial star (··) and extend the other point towards the *north*: at the same time place the rule with its edge in the direction of a parallel of declination, and bisecting both fiducial star (::) and the disengaged point of the dividers.

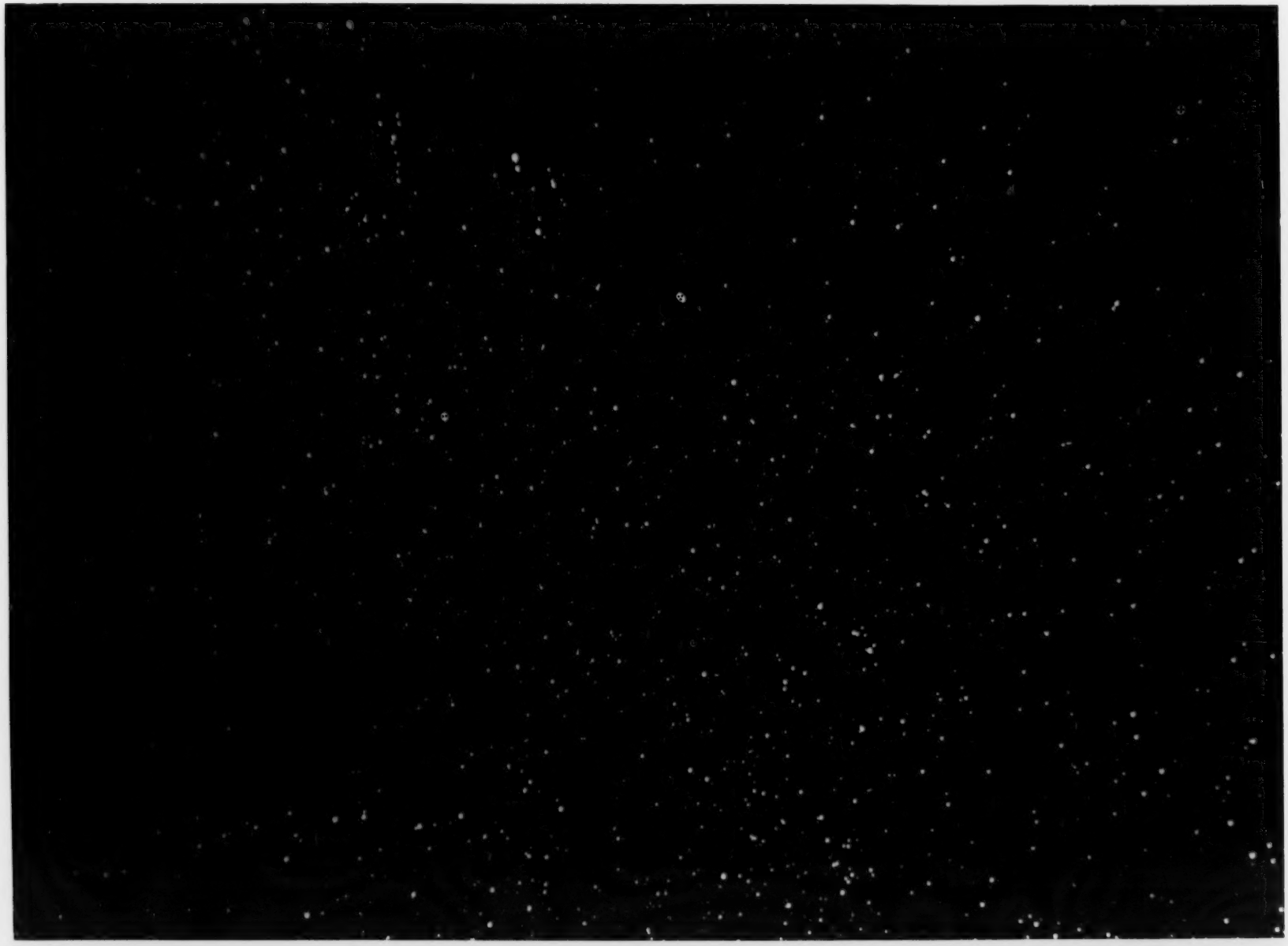
The edge of the rule is then in the parallel of declination of fiducial star (::); and whilst the rule is firmly held in this position, measure the distance of the centre of the group of stars from it, which will be found to be 6·5 millimètres. Then 6·5 × 24″ = 2·6 minutes of arc, and by adding this quantity to the declination of fiducial star (::) we obtain the declination required of the centre of the group: which is 18° 12·5′ + 2·6′ = 18° 15·1′. Refraction in this case will be a small quantity, but if required the correction for it can be made in the usual way.

The fiducial stars (··) and (::) have been chosen in

PHOTOGRAPH OF THE CLUSTER MESSIER 24 CLYPEI.

By ISAAC ROBERTS, D.Sc., F.R.S.

S.



P.

F.

N.

these illustrations because they are the nearest to the object the position of which is required, and it will be understood that the same result could have been obtained by using instead of them any other two of the fiducial marked on the photograph. The fiducial star (: ·:) is Y Sagittarii, which is variable between 5·8 and 6·6 magnitude.

A TABLE

For converting the measured *Right Ascensions* of the Stars shown on the Photographs (which are to the scale of 1 millimètre to 24 seconds of arc) into intervals of time at each Degree in Declination between the Equator and the Pole.

Declination.	1 Millimètre = seconds of R.A.	Declination.	1 Millimètre = seconds of R.A.	Declination.	1 Millimètre = seconds of R.A.
0°	1·60	30°	1·85	60°	3·19
1	1·60	31	1·86	61	3·30
2	1·60	32	1·88	62	3·41
3	1·60	33	1·90	63	3·53
4	1·60	34	1·92	64	3·65
5	1·60	35	1·95	65	3·79
6	1·60	36	1·98	66	3·94
7	1·61	37	2·00	67	4·08
8	1·61	38	2·03	68	4·26
9	1·62	39	2·05	69	4·46
10	1·62	40	2·08	70	4·67
11	1·63	41	2·11	71	4·90
12	1·63	42	2·15	72	5·16
13	1·64	43	2·18	73	5·46
14	1·64	44	2·22	74	5·84
15	1·65	45	2·26	75	6·21
16	1·66	46	2·30	76	6·64
17	1·67	47	2·34	77	7·01
18	1·68	48	2·39	78	7·68
19	1·69	49	2·43	79	8·34
20	1·70	50	2·48	80	9·27
21	1·71	51	2·54	81	10·25
22	1·72	52	2·59	82	11·45
23	1·74	53	2·65	83	13·27
24	1·75	54	2·71	84	15·37
25	1·76	55	2·78	85	18·12
26	1·77	56	2·85	86	23·36
27	1·79	57	2·93	87	30·74
28	1·81	58	3·01	88	48·66
29	1·83	59	3·10	89	97·33

EDITORIAL NOTE.—The August and September numbers of KNOWLEDGE, it is hoped, will contain illustrated articles on the Total Eclipse of the Sun. These articles will be written by Mr. E. Walter Maunder, F.R.A.S., who has arranged to visit Norway on board the *Norse King*, to observe the eclipse.

Notices of Books.

Popular Telescopic Astronomy. By A. Fowler, A.R.C.S., F.R.A.S. (G. Philip & Son.) Illustrated. 2s. There are many who would procure a telescope and direct it heavenwards, but they think that a small instrument is incapable of bringing good views within the vision of an observer. They forget that Galileo's telescope was no better than one which can now be purchased for a couple of shillings; yet he discovered with it the phases of Venus, the stellar constitution of the Milky Way, and four moons of Jupiter. Large instruments have their functions, but there is plenty of work for possessors of smaller ones, and, even if no remarkable discoveries are made, the increased knowledge derived from observation will bring untold satisfaction. With such a guide to the heavens as this of Mr. Fowler's, an observer will soon find his way about the constellations. Of orderly construction, clear composition, and trustworthy character, the book is an ideal companion for students beginning the outdoor study of astronomy. Less than twenty pages are taken up with descriptions by the guidance of which a workable two-inch achromatic telescope can be constructed; the remainder of the book is concerned with the sun, moon, planets, and stars. We confidently anticipate a successful career for a volume possessing all the features required in an introduction to observational astronomy.

An Introduction to the Study of Seaweeds. By George Murray, F.R.S.E., F.L.S. (Macmillan.) Illustrated. 7s. 6d. Many people, actuated by æsthetic considerations, collect and preserve seaweeds, and others do so because they like to possess collections, and think that algæ are as worthy objects of attention as postage stamps. The student is distinct from both these classes; for he collects specimens for the purpose of inquiring into their characteristics and discovering their relationships to one another. This book is intended for such seekers after knowledge, and it possesses all the attributes of a good text-book, being trustworthy, clear, and a true image of the present state of the subject treated. In the opening chapter, Mr. Murray gives an admirable review of the growth of knowledge of "the flora of the sea," and equipped with the facts therein contained students will be in a position to take a clearer and broader view of the subject than if they were launched at once among descriptions of species. A list of selected books and papers on marine algæ follows the introduction, and the remainder of the volume is taken up with descriptions of the various orders of the five sub-classes.

Our Country's Butterflies and Moths, and How to Know Them. By W. J. Gordon. Illustrated. (Day & Son.) Although an extraordinary number of books have been published during the last twelve months on the British lepidoptera, yet they are all quite different, and each one seems to have its use. The object of the book now before us is to provide a handy means for identifying specimens. It aims neither at classification nor at elaborate description. The chief means of identifying specimens by this book lies, therefore, in its illustrations. These consist of a thousand coloured examples by Mr. H. Lynn. Considering their number and the small size of the book these are good on the whole, but we fear that the novice will never be able to identify some of his specimens from them, the colouring in many instances being much at fault. The book is well arranged, however, and should prove useful to the young collector.

Furs and Fur Garments. By Richard Davey. (The Roxburghe Press.) Illustrated. This little book affords both interesting and instructive reading. It deals with the history of furs as garments from the earliest times up to the present, and dwells at considerable length on the fur garments worn by royal and noted persons of different countries and times. The history of the fur trade and of a good many of the fur-bearing animals is also included, as well as the mode of procuring and preparing the skins. The illustrations are excellent, and the book forms a valuable record.

The Artist. (Constable.) The May Number of this monthly is a positive triumph, whether considered from an artistic, literary, or technical point of view. Its motto seems to be "thoroughness." In its own line we do not know a better work, and it should be in the hands of all who concern themselves in art matters. The supplement, "The Harvest of the Studios," with its wealth of fine reproductions, makes this number a truly wonderful sixpennyworth.

XUM

SHORT NOTICES.

Principles of Metallurgy. By Arthur H. Hiorns. (Macmillan.) Illustrated. 6s. The author's "Elementary Metallurgy" is already well known to students of the subject, and the present work forms an admirable sequel to it. Besides explaining the principles of metallurgy, and giving other valuable information, it expounds the views of modern metallurgists, and the methods of extracting various metals from their ores.

First Stage Mechanics. By F. Rosenberg, M.A. (Clive.) 2s. This work has been designed, we are told in the preface, to cover the requirements of the elementary stage of the Science and Art Department in the theoretical mechanics of solids. To this end the work is eminently successful.

Practical Inorganic Chemistry. By G. S. Turpin, M.A., D.Sc. (Macmillan.) Illustrated. 2s. 6d. This is a clear and practical guide to elementary chemistry.

Submarine Telegraphy. By James Bell and S. Wilson. (*Electricity.*) Illustrated. 1s. 6d. This book is composed of reprints of papers which were published under the heading of "Technical Telegraphy Papers" in *Electricity*. It should prove useful to telegraphists.

Messrs. Wesley & Son send us a very full catalogue of valuable books which should be seen by every zoologist.

BOOKS RECEIVED.

Artistic and Scientific Taxidermy and Modelling. By Montagu Browne, F.G.S., F.Z.S. (A. & C. Black.) Illustrated. 21s.

Introduction to the Study of Fungi. For the Use of Collectors. By M. C. Cooke, M.A., LL.D. (A. & C. Black.) Illustrated. 14s.

A Dictionary of Chemical Solubilities—Inorganic. By A. M. Corney, Ph.D. (Macmillan.) 15s.

A Compendium of General Botany. By Dr. Max Westermaier. Translated by Dr. Albert Schneider. (New York: Wiley. London: Chapman & Hall.) Illustrated. 8s. 6d.

The Elements of Physics. By E. L. Nichols and W. S. Franklin. Vol. I.—"Mechanics and Heat." (Macmillan.) Illustrated. 6s.

A Handbook of the Order Lepidoptera. By W. F. Kirby, F.L.S., F.E.S. Part I.—"Butterflies." Vol. II. Allen's Naturalist Library. (Allen.) Illustrated. 6s.

Handbook for the Bio-Chemical Laboratory. By J. A. Maudel. (New York: Wiley. London: Chapman & Hall.) 6s. 6d.

Milk: its Nature and Composition. By C. M. Aikman, M.A., D.Sc. (A. & C. Black.) Illustrated. 3s. 6d.

Meteors and Sunsets observed at Lick Observatory in 1893, 1894, and 1895. (Sacramento: A. T. Johnston.) Illustrated.

Biological Experimentation. By Sir B. W. Richardson, M.D., F.R.S. (Bell & Sons.) 2s. 6d.

Notes on the Revised Latin Primer. By A. A. Ogle, B.A. (Relfe.) 1s.

WAVES.—VI.

STANDING WAVES IN FLOWING WATER.

By VAUGHAN CORNISH, M.Sc.

WAVES of flowing water are the familiar surface corrugation of babbling brooks, rippling streams, mountain burns, the rapids of rivers, and the tide races of the sea. There are also most beautiful varieties of these waves to be seen where water cuts a channel through a sandy bed in making its way across the beach to the sea, as shown in Fig. 1.

If a stone too heavy for the current to move be thrown into a shallow, rapid, brook, the water rises in a heap over the obstacle, the forward motion of the water being checked, and an upward slope being given to the current, whilst on the lee side of the obstacle the water gathers speed as it slides along the downward slope of the billow, and falls below the proper level of the stream. If we watch attentively the course of events, we find that a second billow is quickly formed to leeward of the first, and then a third and a fourth, and so on; until the lengthening group of diminishing waves extends to a considerable distance down stream. Each wave crest maintains its position relatively to the stone, and from this comes the term *standing* wave, for there is apparently no bobbing up and down as in the stationary (*i.e.*, non-progressive) sea waves which may be seen near a vertical breakwater, or in harbours, or in docks. Sometimes, however, they are called stationary waves of flowing water, but standing waves is a more descriptive term. It is further to be noticed that although the wave crests are stationary relatively to the stone which produced them, yet they travel relatively to the water. The stone and the water are in relative motion, just as when a boat is tugged along a canal the boat and the water are in relative motion. A canal boat, if moving sufficiently quickly, is followed by a group of waves, each crest keeping its position relatively to the boat as long as the velocity of the boat remains the same. Most of the facts which are known about canal-boat waves may be applied directly to standing waves in shallow streams. If the stone which we used to form the group of standing waves be slowly rolled down stream by the force of the current, the group of waves moves with it. If, on the other hand, we attach a cord to the stone and drag it up stream, the group of waves travels up stream with the stone. If the velocity of the stream should slacken, the length from crest to crest of the waves to leeward of our stationary stone is diminished; if, on the other hand, the stream should swell, and flow more quickly, the wave-length is increased. The relation of wave-length to velocity is the same as in the case of canal-boat waves.

The differences of level in the standing waves are such as to balance the differences of horizontal pressure, the free surface of the water being a surface of uniform pressure. Thus the height of the first hillock of water depends upon the pressure of the stream upon the stone. It will be noticed in looking at the waves of rapid streams that their steepness is often much greater than that which is attained by wind-formed waves, and is comparable to the steepness of "steamboat waves." When a particle of water has been forced by the current to the summit of the heap which surmounts the stone, gravity pulls it down, and the inertia of the motion thus imparted carries it below its proper level, from which the hydrostatic pressure of the neighbouring water again raises it; and so the oscillation goes on, the amplitude diminishing at each swing. The particle, however, has a forward motion given by the current, as well as the pendular oscillation, so that at the end of the oscillation the particle is not in the same position as that from which it started. The pull of gravity causes the particle to occupy successively positions above and below the proper stream level. There is also an alternate backward and forward motion relatively to the current, as the current would be if the stream were allowed to flow uniformly without the interruption caused by the stone. The forward motion of the surface particle is retarded when it is above the mean level of the stream and accelerated when it is below the mean level. On the whole, therefore, the *wave motion* of the particle is the repeated description of a closed curve about the positions which it would successively occupy if flowing in the undisturbed stream. The actual motion compounded of current and wave motion of a particle on the corrugated surface of a stream is similar to the motion of the car of the switchback railway: slow, horizontal, on the top of the hill, gaining velocity on the downward slope, flying up the lower portion of the next hillock with the aid of the momentum gained in its fall, but with slackening speed as it rises; its velocity less than that proper to the stream at all points above the nodal line of the undisturbed level of the stream, greater than this at all points below the nodal line. That the general velocity of the stream under the troughs is greater than that under the crests, is sufficiently obvious from the fact that when a group of standing waves has been formed the current which flows is constant in quantity. Therefore the same

amount of water passes per second across a shallow section (under the troughs) and across a deep section (under the crests).

If the stone be tugged up stream the length from crest to crest is greater than if the stone be at rest, for the velocity of the current relatively to the stone is increased. As the speed of the stone up stream is increased the wave-length continually increases, but the train of waves becomes shorter, as in the case of a canal boat, until, when the velocity of the stone relatively to the current is equal to the velocity of a free long wave in a channel of the given depth, there is no longer a train of waves but a single hillock accompanying the motion of the stone. When this state of things has been reached the vertical oscillation of the water particle is insignificant compared with the horizontal component of the motion. For shorter waves from stationary obstacles in ordinary shallow streams the motion is presumably elliptical or approximately so, the ellipse becoming more nearly a circle for shorter waves in deeper water. If we were to push our experiment of dragging a stone up stream beyond the critical velocity, the effect would be that the stone would leave the "solitary" wave behind it, the velocity of a free solitary wave being strictly limited by the depth of the stream. In this way a number of independent solitary waves might be produced on the lee side of the stone.

If, on the other hand, we were to watch what takes place when the current rolls a stone down stream, we should find the wave-length shorter than in the case of a stationary stone, because the relative velocity of stone and current is diminished.

In all cases where a *group* of waves is formed, one wave making many, the energy travels slower than the wave; it falls behind the wave and makes another, so that the group lengthens, the tail of the group moving more slowly (relatively to the current) than the head, just as in the track of ships (*vide* Knowledge, March and April, 1896).

It will often be noticed that the first wave crest to leeward of a stone in a shallow stream (the first wave being that which has greatest amplitude) is a cusped or breaking wave, the cusp being, of course, on the up-stream side. This happens when the downward rush of the water on the lee side of the obstacle carries the water surface far below the proper level of the stream, so that under the trough the water is very shallow, and under the crest relatively deep. This is a similar condition to that of the breaker of the seashore: the wave velocity in the crest is greater than that in the trough; the crest therefore gains upon the preceding trough and overhangs it with a trembling cusp. But the cusped wave to leeward of a stationary stone in a shallow stream does not usually fall bodily forward, as finally happens with the wave breaking on the beach, for it remains in the same depth of water Occasionally, however, when the current happens to be.

Fig. 1.—Rhossilby Bay. From a Photograph by Mr. F. H. Worsley-Benison.

momentarily diminished, the cusped wave will roll forward and fall, like the breaker on the seashore.

In passing, it may be mentioned that the foam from the cusp of a standing wave is not ordinarily like the creaming froth of the sea breaker; the bubbles are coherent, well formed, and often of large size. Sometimes they may be seen rolling like glass marbles on the up-stream slope of the cusped wave.

During the return of a breaker, when a current of water is running down the slope of the beach, one may, under favourable circumstances, see all gradations between the standing waves of running water and the ordinary waves of the sea, which are running waves in standing water. The best conditions are a moderately sloping beach and a long interval between the arrival of succeeding breakers. The stream made by the return of the breaker is constantly shallowing on the land side and becoming deeper on the seaward side. Hence, if the pebbles which are dragged seawards with the current, or any other irregularity of the bottom, should corrugate the surface of the stream, we may get a true breaker in running water: the back of the wave is accelerated (*i.e.*, is hastened shorewards) as the water deepens to seaward; the front of the wave is retarded as the water shallows on the land side; and at last the little breaker is stranded and falls flat upon the beach. More often than not the next incoming sea wave has arrived before this happens, and this gives a similar but more striking effect. This is the little breaker, which may be noticed on calm days and when the wind is off shore, of which the bottom seems to be tripped up by the heels—if one may be allowed the expression—the whole of the advancing ridge falling "flop" upon the shore. If the beach be sandy the water in this breaker is always yellow and turbid, even on a calm day when the ordinary breaker is clear and transparent.

If there happens to be a shoal close to the shore, standing waves may often be seen where a current is set up parallel to the coast in the channel between the shoal and the beach. This affords a good opportunity of watching running waves and standing waves on the same sheet of water; and the foam on the surface enables one to discriminate readily the two kinds of wave, for the foam in the current travels with the stream, passing over the standing waves, whereas the running waves pass the foam, leaving it behind them. The waves of running water are to be seen on the grand scale in the tide races, which run like rivers in the sea—sometimes, as off Portland Bill, with a velocity of six or seven knots. If the water be rather shallow, standing waves are caused by irregularities of the bottom, but this is not the only way in which they are produced. Anything which makes an extra pressure at any point in a stream gives rise to standing waves. They arise, for instance, where a current meets still water, as is the case on either edge of the rapid current which flows out through the opening in Portland Breakwater. When two currents meet at an angle, standing waves are also raised.

FIG. 2.—Rapids on the Tees. From a Sketch.

When the surface of the sea is agitated simultaneously with wind waves and standing waves, the result is a wild turmoil of waters almost impossible to follow with the eye or to analyze with the mind. The races and overfalls of the Channel are described with a certain rough picturesqueness in the "Sailing Directions for Pilots." The following account of Portland Race is from the twelfth edition of "The Pilot's Handbook for the English Channel":—"From about 2h. to 11h., F. and C. (or from the time of ½ ebb to nearly the end of flood in Portsmouth Harbour), there is an outset from the West Bay, on the N.W. side of Portland, of nearly 9h. duration, which closely skirts the rocky shore, and gradually increases in strength as it approaches the Bill, where it acquires such velocity as to extend far beyond that point before it turns to the E., leaving a strong eddy between it and the land. Having assumed its E. course, it rushes 6 or 7 knots an hour, during springs, past the pitch of the Bill, leaping and foaming over Portland Ledge with great violence. . . . . During spring tides the

agitation is so violent in the Race as to render it dangerous for small vessels; and in tempestuous weather, when the West channel stream is running to the eastward, the whole space between Portland and the Shambles is one sheet of broken water."

In the older "Sailing Directions for the English Channel" (1835), Captain White, R.N., gives a very explicit account of the causes which produce the standing waves in the principal races and overfalls of the Channel. The following passages are condensed from this book:—"Off Scilly, S.E. and South of St. Agnes Island, there is great rippling or overfall, between IV. hours flood and II. hours ebb, occasioned by the confluence of two streams of tide there at that period. . . . . Off the Lizard, south of the Stag Rocks, there is always an extensive rippling on both streams of tide; but this is chiefly occasioned by the unevenness of the ground. There is another extensive race, or rippling, to the S.E. of the Lizard (off Black Head), occasioned by the confluence of the tides. Off the Start there is considerable rippling, occasioned by the confluence of the fair-channel tide with the in-shore streams between Start Point and Dartmouth and within the Skerries. The Portland Race is caused by the rocky ledge which projects somewhat more than a mile in a southerly direction from the Bill; both sides whereof being remarkably steep, the consequent transition from deep to shoal water is very sudden. The overfalls off St. Alban Head are chiefly caused by the unevenness of the ground. The overfalls off St. Catherine and Dunnose are also partly caused by the various sudden transitions from deep to shoal water in that neighbourhood."

A group of standing waves may originate from a hole in the bed of a stream as well as from a hump on the bottom. It depends upon the velocity and depth of the stream whether the water will be raised or depressed over the hole; in a rapid shallow stream it is depressed over the hole. Hollows worked in the bottom of a stream flowing across a sandy beach frequently originate a train of standing waves. These holes are, I think, generally formed by the action of an eddy, or upward swirl in the water. The sand which rolls along the bottom of the stream keeps filling in the hole on the up-stream side, but the vortex scours away the sand on the lee side, so that the hole moves down stream. With it, of course, the group of standing waves to leeward moves down stream also. Another way in which standing waves are formed in these streams is by the convergence near the middle of the stream of ridges of water maintained by the pressure of the current upon the opposite banks. This gives rise to waves of very little lateral extension, but often of considerable height at their middle part. These likewise move down stream as the banks are continually eaten into by the currents. The most interesting thing about these groups of waves is that under each is a group of *sand waves*, which, when we look straight down upon the stream, are often more conspicuous objects than the corrugations on the surface of the clear water. Fig. 1 shows the kind of locality in which to study such sand waves, and the kindred phenomenon of Ripple-Mark. Fig. 3 shows a water wave and sand wave, the dimensions being from actual measurements. It will be noticed that the wave is deeper over the crests than over the troughs, the amplitude of the water waves being greater than that of the sand waves. In order to watch standing water waves carving ridge and furrow in a sandy bottom, I have strewn sand on the lee side of a stone fixed on the hard bottom of a stream. To the leeward of the stone were standing water waves, and as the sand was rolled down by the current it was rapidly carved into ridge and furrow of symmetrical form. In this case the stone was fixed, and the positions of the corrugations of the water surface were also fixed relatively to the banks of the stream. The grains of sand could be watched rolling rapidly over the furrowed bottom, but the ridges and furrows in the sand maintained their positions unaltered as long as the supply of sand was kept up. This means that the sand wave is travelling against the stream with the same velocity as that with which the sand grains travel with the stream.

In the case of sand waves under a group of standing waves which are moving down stream, the sand ridges move down stream also, keeping pace with the corrugations of the surface. The movement of the sand wave can be watched, and will repay the trouble of watching. If a small flat stone be dropped into a furrow or trough, it is speedily buried by the surface sand which rolls down upon it from the proceeding crest on the weather side. It is always the surface sand that moves, the lower layers

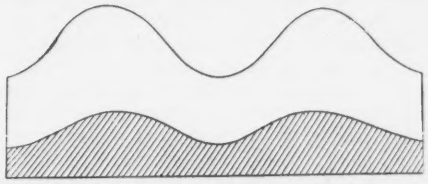


FIG. 3.—Waves of Flowing Water and Rolling Sand.

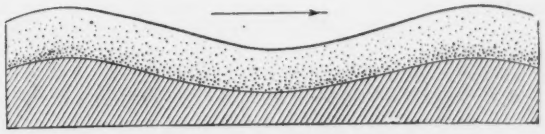


FIG. 4.—Waves of Flowing Water and Flying Sand.

having to be uncovered before they roll freely. Soon the stone is under the crest of a sand wave, presently it emerges on the up-stream side as the crest moves on. These are waves of *rolling* sand in which the top layer moves; but it is not always the same grains of sand which are at the top. The grains at the surface of the weather slope of a ridge are carried over to the trough, and are speedily buried by the grains of the next layer brought from the weather slope of the ridge; and so the motion of the ridge continues, the grains moving very quickly, but the form of the sand progressing slowly because the ridge contains many layers of sand grains. The down-stream movement of the ridges is the motion of the *group* of sand waves, and the velocity of the ridges relatively to the bank is the group velocity. Above the compact but mobile sand which forms these waves the water is clear: there is no flying or floating sand.

Further down the stream, when the water is flowing strongly, matters are different. The stream gathers sand as it goes, largely by erosion of the banks, and, as we near the sea, the sand is looser. The sand flies along in a turbid current of sand and water, sometimes covered by clear water, but often rendering the whole stream turbid. At those places where the stream narrows and the waters rush together from the sides, or where two minor channels converge, or where pressure-ridges from impact of water with the sides of the channel meet, the water is thrown into standing waves, close under which sand waves are formed. These waves move *up stream*; yet their origin is generally in the action of the water upon sand which is constantly being carried down stream. Even if they originate from a

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stone firmly fixed in the bed the waves move up stream, though the head of the group cannot advance beyond the stone. It often happens that the condition which produced the corrugation of the water surface is annulled, leaving the group of waves still in existence, and the waves continue to move up stream. It is then interesting to note what happens to the first wave of the group which is exposed to the action of a straight-forward current. It continues to move up stream, the crest of water above and the ridge of sand below; but the sand ridge becomes lower and lower, its up-stream motion continuing, however, until the ridge has been quite scoured away. The first water wave has now disappeared, and the second sand ridge is exposed to the straight-forward current and is in like manner scoured away—persevering, however, to the end in its up-stream motion. Thus the whole group is obliterated, but for a time the sand ridges maintain the corrugations on the surface of the water. It is also to the sand waves, I believe, that the up-stream motion of both sand wave and water wave is due. We have here to do with flying sand, as I have said, and flying sand is also falling sand. There is a constant sand-rain falling through the water, and it is often possible to see quantities of sand dropping on the upper half of the weather slope of the ridges. Of course, the sand does not drop vertically; it falls very obliquely, for the downward motion through water is slow. Consider, then, as a first approximation, that the sand-rain comes down obliquely in straight lines. The weather slope of a sand hill, which is tilted up to meet the shower, is of course more exposed to the shower than the leeward slope; so that when there is much flying sand in the stream the sand ridge moves up stream, carrying with it the water ridge. When the up-stream waves extend the whole way across the channel, the path of the sand particles may sometimes be seen to be curved outward towards the edges of the stream, a motion which seems to help in building up the ridges at their two ends, and which probably assists to some extent the up-stream motion.

By examining the waves somewhat higher up the stream, it is often possible to hit upon the position where the waves are stationary; still higher up one may sometimes see very similar waves which are going down stream, in which the shower of flying sand is not sufficiently dense to maintain the ridges in place.

A RARE METAL.

By T. L. Phipson, Ph.D.

At the beginning of this century the great Swedish chemist Berzélius discovered a new metal in some Norwegian rocks, and dedicated it to the mythological deity of the ancient Scandinavians, the god Thor, by calling it *thorium;* the mineral in which it was found was also called thorite.

It was at a period at which great activity was manifested in the search after new substances contained in rocks, minerals, and rare or precious stones. Chemists had not yet made much way into the mysteries of the organic world. They were not acquainted with the marvellous products which have since been derived from plants; animal chemistry was very little known; but a great insight was being obtained into the nature of the constituents of minerals, and ever since the middle of the eighteenth century discoveries of new metals were being made with astonishing rapidity.

During this extremely interesting period of scientific research, when men like Humphry Davy, Lavoisier, Klaproth, and Berzélius vied with each other as discoverers of the secrets of nature, considerable numbers of most curious substances were brought to light—metals which, to this day, are scarcely known, even by name, to the general public, and are still little enough known, indeed, to the most eminent of our modern chemists. Cerium, for instance, was found in a kind of granite rock in Sweden, glucinium in the emerald and beryl, zirconium in a precious stone from the East called jargon, and titanium in the black sand of some Cornish streams.

When a new substance is thus discovered, the thought that it may some day be applied to a useful purpose is generally quite absent from the mind of the discoverer. He is perfectly satisfied with the novelty of the discovery. Only those who pass their existence in a laboratory devoted to research can realize the intense interest with which every new property of these rare curiosities is studied. The book of nature is really more attractive than the finest pages of the greatest writers, and as its secrets are gradually revealed they rivet the attention more and more, quite independently of the possible application of these revelations to any particular art or industry. Nevertheless, it must be confessed that in these practical days such considerations are not always so entirely absent from the mind as they used to be.

It is needless, perhaps, to say that, of all the new metals which have come to light since the middle of the last century, very few have come to any extent into daily use. Hitherto, by far the most unpromising, perhaps, in this respect, has been the metal *thorium*, and its oxide *thoria*. It was found in a black, shiny mineral, resembling black glass, sticking in the Norwegian granite rocks, and afterwards in a few other stones of various colours, where its presence was thought to be accidental. It possessed no very striking properties. The oxide (thoria) is white, and forms white salts with acids; no colours are obtained with it. In fact, it was no more interesting in its chemical behaviour with other substances than common lime, to which it bears a good deal of resemblance. But it was very heavy, very infusible, and very rare; and it was certainly quite distinct from any substance which the crust of the earth had, as yet, yielded to the inquisitive searcher after new metals.

Thoria was first found combined with silica upon the little island of Loeven, not far from the small town of Brevig in Norway. It was discovered by a Swedish diplomatist named Esmarck, and handed to his friend, the chemist Berzélius, that he might analyze it and so find out what it was. In making this analysis Berzélius soon discovered that he was dealing with an entirely new substance. Some time afterwards the same new substance was found by the late Prof. Woehler, the celebrated chemist of Göttingen, and a pupil of Berzélius, in a stone from the Ural Mountains called pyrochlore, which is also found in Norway; and more recently it has been met with in another rare mineral called monazite.

It was soon seen to be extremely difficult to smelt the metal out of the oxide of thorium, as we get iron or copper out of their oxides, by heating it to a very high temperature with coal or charcoal. However, Berzélius did manage to get out a minute quantity of the metal by other means, and obtained it as a metallic powder, not unlike lead in colour and appearance. He found that when this metal was heated red-hot in the air it took fire, and burnt with a most extraordinary brilliancy. The light emitted was even more strikingly brilliant than that produced by the combustion of magnesium, which is at present so much used by photographers and makers of fireworks.

Now, this light-giving property of thorium is just bringing out this rare metal from the complete oblivion in which it has lain for nearly seventy years. Whilst we are writing these few lines search is being made in many parts of the world for stones, rocks, or sands which may perchance contain a certain quantity of this now precious substance, hitherto a mere useless chemical curiosity.

It has been found out, indeed, that of all the metallic oxides which have been tried on the so-called "hoods" or "mantles" that are placed around gas-flames in order to increase the light, thoria is by far the finest; and of recent years the manufacturers of these "mantles" for the incandescent gas-burners have created a brisk demand for thoria.

The consequence of all this is that, at various times during the last two or three years, *a pound weight* of this hitherto useless substance, thoria, has been freely sold at forty-five to fifty pounds sterling.

The incandescent light yielded by the "mantles" of thoria are enabling the street gas to rival the more expensive electric light; and employment in new fields is already being found for thousands of hands, thanks to the discovery, about seventy years ago, of a new substance, apparently of very slight interest, and long considered to be absolutely useless.

The minerals thorite, orangite, and pyrochlore, which all contain a large amount of thoria, are still very rare and expensive; but monazite has been found of late years in various parts of the world, and seems more plentiful, and as it generally contains about eighteen per cent. of thoria, it now forms the centre of a new and rising industry.

However, this mineral, monazite, is by no means common. It is rather heavy, weighing about five times its own bulk of water. In several regions of the United States and Canada, principally near Quebec and in North and South Carolina, it is met with in the sand and gravel which form the bed of small streams, the richest deposits being usually found near the head waters, among the detritus of gneiss rock and schists, where it is associated with several other minerals. In such localities it is either seen in pure crystals—ranging in colour from yellow to brown and yellowish green—sometimes as large as a grain of wheat or even larger, or as "monazite sand," in which minute crystals of the mineral are diffused or mixed with much ordinary sand and other worthless material. The principal district is North Carolina, the sands of which yield from two to four per cent. of monazite crystals. Similar sands are now being shipped from the coast of Brazil, which yield from one and a quarter to seven and a half per cent. of monazite. Some monazite sand also comes from Quebec. On the southern coast of Bahia it is found on a sandy beach of enormous extent, and is now being shovelled up from this beach into small vessels of some four hundred to five hundred tons and of light draught, and shipped to England or Hamburg. Norway is also supplying a certain quantity of the minerals thorite and orangite, which are very rich in thoria. About one ton weight per annum of these thorium minerals, representing seven thousand pounds worth of thoria, is the present output from the South of Norway.

Soon after the introduction of the new incandescent gas burners the demand for minerals containing thoria increased to a considerable extent. The first offered were the Norwegian thorite and orangite ores, which contained from forty to sixty-two per cent. of the rare oxide. At first the price paid for pure oxide of thorium was as high as fifty-three pounds for one pound weight avoirdupois; but it has since oscillated very much, and has sometimes been as low as seven pounds per pound, according as the output is more or less plentiful.

We have, perhaps, said enough to show that a new and highly interesting branch of industry has arisen in a most unexpected manner, from a chemical discovery which, at the time it was made, and ever since, has been generally regarded as one of the most useless and least promising, from a commercial point of view, in the whole annals of scientific research.

SERTULARIAN POLYPIDOMS; OR "HORNY CORALLINES."

By P. L. ADDISON, F.G.S., Assoc.M. Inst.C.E.

THE heaps of tangle which lie at high-water mark along our coasts contain a variety of objects it would be almost impossible to catalogue, but which, with certain exceptions—such as cabbage stalks, old boots, and the like—are all of more or less interest to the naturalist. The principal mass of the tangle consists of a great variety of seaweeds, ranging from the thick stems of the common bladder-wrack to the most delicate fronds of the *Griffithsia* and *Cladophora*. Clusters of egg-cases of the whelk, like balls of sea foam that have been petrified, egg-cases of the skate, defunct starfish, sea-urchins, and small crabs are among the first objects which arrest attention. All these have an attraction of their own, but it is to the remains of a much less conspicuous class of marine animals that we now wish to draw the reader's attention. These are the polypidoms or polyparies of the zoophyte family *Sertulariida*: small, graceful, branching, tree-like objects, which are usually

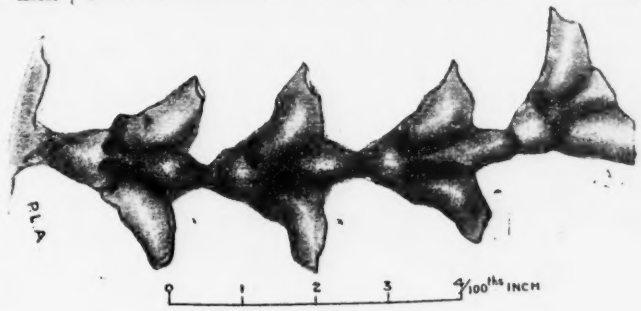


FIG. 1.—*Sertularia gracilis.*

found in the tangle in great variety after a storm. They are often mistaken for seaweed by the casual observer, and were formerly considered to belong to the vegetable world. They are frequently called "corallines," or "horny corallines"; but the popular names must not allow them to be in any way associated with the common coralline (*Corallina officinalis*), which is a true but very remarkable form of marine alga.

With the help of a small pocket magnifier it may easily be seen that along each side of the stem and branches of the polypidom are arranged minute cup-like projections, placed alternately, or opposite to each other, according to the species of Sertularia to which they belong. In the allied Plumularia the cups are on one side of the stem and branches only.

Sertularian zoophytes are very similar in bodily struc-

ture to hydra, or fresh-water polypes; but differ in their mode of life, inasmuch as they live in colonies, constructing and inhabiting the horny polypidoms already mentioned. The active part of the body of the animals is contained in the polype cells, and is provided with a mouth surrounded by fine contractile tentacles. These are extended in the sea-water, and wave about in search of tiny particles of food, which are conveyed to the mouth, and passing direct into the body are there digested and assimilated.

The lower part of the body of each polype is prolonged through the base of the cup into the tube or cœnosarc running through the stem and branches of the polypidom, and is thus united with the common body, to which each polype contributes a share of nourishment through the assimilation of food in its own body. Under such conditions it would be quite possible for many members of the sertularian colony to live for a certain length of time through the exertions of their brother polypes without troubling to collect food for themselves.

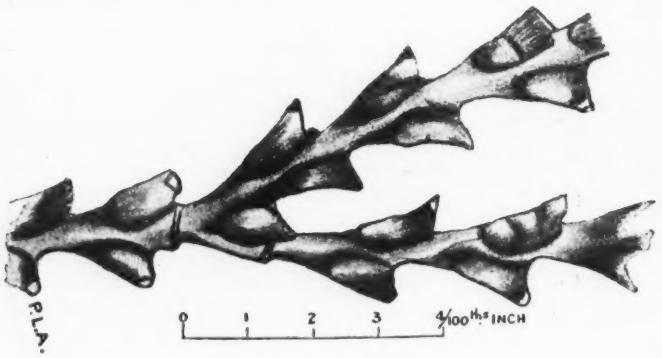


FIG. 2.—*Sertularia argentea.*

The system of growth and reproduction in the sertularian colony is as follows: new polype buds arise from the cœnosarc of the stem and branches of the polypidom and enlarge its horny substance into beads or globules. As the buds develop, their horny cases open and form cups, each one of which contains a fully developed polype.

Sertularia, though differing in certain points, are generally considered to be the modern representatives of, and closely allied to, the graptolites, so common and found in such variety in the lower and upper Silurian formations.

Figs. 1, 2, 3, and 4 are reproductions of microscopic drawings of characteristic sertularian polypidoms, showing the different form and arrangement of the cells which formerly contained the living animals; and, in order that the dimensions of these structures may be easily determined, we have added a scale of one one-hundredth of an inch to each drawing. But this is not enough to convey any idea of the delicate structure of the polypidoms or of the vast number of polypes that formed the colony. With the hope of making this more clear, we have taken some of the branches of *Sertularia argentea* (Fig. 2), and find that they contain one hundred and seventy-eight cells, and that the weight of these naturally dried fragments is ·0004 of a gram, or about one five-hundredth part of a grain. The tree-like polypidom from which these were taken is nineteen centimètres (about seven and a half inches) in length, and its weight is ·123 of a gram.

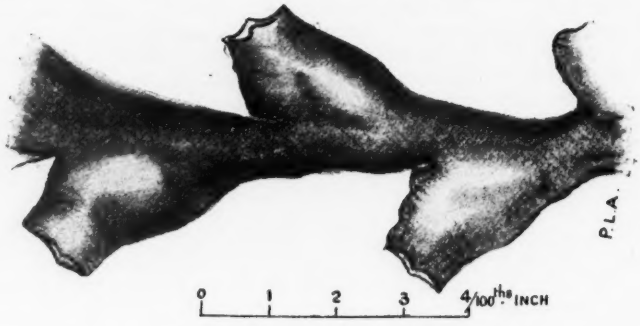


FIG. 3.—*Sertularia abietina.*

We are therefore confronted with the fact that the whole colony—and this specimen is by no means a large one, weighing when dry less than two grains—must have consisted of nearly fifty-five thousand individual polypes.

In preserving these objects for future reference it is enough to mount them dry in shallow cells formed by thin vulcanite or zinc rings. They should first be thoroughly washed in warm water and then allowed to become perfectly dry. The cell and cover-glass should be heated over a spirit lamp, so as to destroy mould spores without injuring the specimen, before it is hermetically sealed. Balsam and balsam and benzole mounting often tend to over-clarify these objects when examined under transmitted light; and air bubbles which form in the cœnosarc and polype cells—even when great care is exercised to avoid their occurrence—give a false impression of the structure of the polypidom. It is true that these difficulties may be overcome by the use of an air pump; and if it is desired to examine the objects under polarized light, it is necessary that a much more elaborate

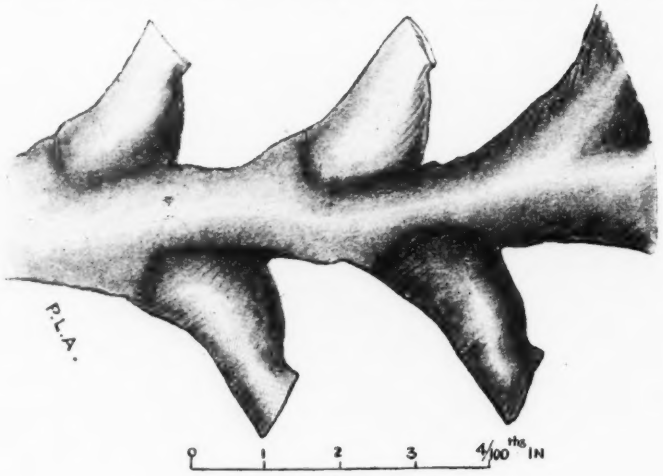


FIG. 4.—*Sertularia pinaster.*

system of mounting should be resorted to than that we have suggested as being sufficient for ordinary observation and recognition of species.

What power of instinctive inclination endows these simple and minute animals, and induces each species to constantly adhere to a particular design in the formation of its abode—why each member of a colony seems to be thoroughly educated in the work it has to perform while helping to build a branch of the polypidom so that it may exactly coincide with all the others—is one of the deeply hidden mysteries connected with the lower forms of animal life.

THE FACE OF THE SKY FOR JUNE.

By HERBERT SADLER, F.R.A.S.

SUNSPOTS and faculæ are rapidly diminishing in size and number.

Mercury is an evening star during the first week of the month. On the **1st** he sets at 9h. 2m. P.M., or 57m. after the Sun, with a northern declination of 22° 34′, and an apparent diameter of 11½″, about $\frac{8}{100}$ths of the disc being illuminated. On the **4th** he sets at 8h. 41m. P.M., or 34m. after the Sun, with a northern declination of 21° 39′, and an apparent diameter of 11¾″, $\frac{3}{100}$ths of the disc being illuminated. He is in inferior conjunction with the Sun on the **10th**, and after that becomes a morning star. On the **26th** he rises at 3h. P.M., or about three-quarters of an hour before the Sun, with a northern declination of 18° 44′, and an apparent diameter of 9⅛″, about $\frac{2}{10}$ths of the disc being illuminated. On the **30th** he rises at 2h. 47m. A.M., or about 1h. before the Sun, with a northern declination of 19° 30′, and an apparent diameter of 8½″, $\frac{28}{100}$ths of the disc being illuminated. During the first week in June he pursues a short retrograde path in the eastern border of Taurus, and during the last week a short direct path in the same quarter.

Venus is invisible, and Mars, for the observer's purposes, is in the same condition.

Jupiter is an evening star, but is so near the Sun that we only continue his ephemeris during the first three weeks of the month. On the **1st** he sets at 11h. 41m. P.M., with a northern declination of 19° 34′, and an apparent equatorial diameter of 34¼″. On the **8th** he sets at 11h. 16m. P.M., with a northern declination of 19° 16′, and an apparent equatorial diameter of 33¾″. On the **18th** he sets at 10h. 41m. P.M., with a northern declination of 18° 47′, and an apparent equatorial diameter of 33″. While visible he describes a short direct path in Cancer, being about ¾° north of δ Cancri on the **10th**. The following phenomena of the satellites occur while the planet is more than 8° above and the Sun 8° below the horizon:—On the **2nd** a transit ingress of the first satellite at 9h. 27m. P.M., an occultation disappearance of the second satellite at 9h. 31m. P.M., and a transit ingress of the third satellite at 9h. 57m. P.M. On the **4th** an eclipse disappearance of the first satellite at 10h. 3m. 5s. P.M. Jupiter will be occulted by the Moon on the evening of the **14th**. The disappearance will occur at 9h. 52m. P.M., at an angle from the north point of 113° (reckoning from N.E. to S.W.), and reappear at 10h. 43m. P.M., at an angle of 293°. The four bright satellites will also be occulted.

Saturn is an evening star. He rises on the **1st** at 5h. 16m. P.M., with a southern declination of 13° 38′, and an apparent equatorial diameter of 17½″ (the major axis of the ring system being 43″ in diameter, and the minor 15″). On the **10th** he rises at 4h. 34m. P.M., with a southern declination of 13° 30′, and an apparent equatorial diameter of 17¼″. On the **17th** he rises at 4h. 4m. P.M., with a southern declination of 13° 26′, and an apparent equatorial diameter of 17″ (the major axis of the ring system being 42¼″ in diameter, and the minor 14¾″). On the **30th** he sets at 1h. 4m. A.M., with a southern declination of 13½°, and an apparent diameter of 16¾″. During the month he pursues a retrograde path in Libra, being less than ¼° south of μ Libræ (5¼ magnitude) on the **30th**. μ Libræ is an exceedingly beautiful double star (5½, 6¼ magnitudes), the components being 1½″ apart.

Uranus is an evening star, but owing to his great southern declination is not well situated for observation. On the **1st** he rises at 6h. 5m. P.M., with a southern declination of 17° 56′, and an apparent diameter of 3·8″. On the **30th** he rises at 4h. 6m. P.M., with a southern declination of 17° 41′. During the month he describes a very short retrograde path in Libra, without approaching any naked-eye star.

There are no well-marked showers of shooting stars in June.

The Moon enters her last quarter at 8h. 2m. A.M. on the **3rd**; is new at 8h. 43m. A.M. on the **11th**; enters her first quarter at 11h. 41m. A.M. on the **18th**; and is full at 6h. 53m. A.M. on the **25th**. She is in apogee at 8h. A.M. on the **5th** (distance from the Earth, 251,430 miles), and in perigee at 4h. P.M. on the **20th** (distance from the Earth, 229,000 miles).

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 10th of each month.

Solutions of May Problems.

(A. C. Challenger.)

No. 1.

1. Kt to K4, and mates next move.

No. 2.

Key-move.—1. Kt to Kt4.

If 1. . . . K to K6,	2. Kt to B2ch, etc.
1. . . . P×P,	2. Kt×Pch, etc.
1. . . . Kt to Q7,	2. Q to Q5ch, etc.
1. . . . Kt (or P) to K6,	2. Q to K5ch, etc.
1. . . . K to B4, etc.	2. Kt to B2, etc.

CORRECT SOLUTIONS of both problems received from H. S. Brandreth, H. S. Quilter, G. A. F. (Brentwood), Alpha, and W. Willby. Of No. 1 only, from A. E. Whitehouse, J. W. Bilbrough, J. M'Robert, and A. S. Coulter.

Solutions received too late for acknowledgment from J. M'Robert (two-mover in March Number), and G. A. F. (Brentwood), (April problem).

J. W. Bilbrough.—Have you considered the defences—1. . . . P×P, and 1. . . . P to K6?

A. G. Fellows.—Many thanks.

G. G. Beazley.—If 1. Kt to Kt4, B to B6 is the defence.

H. H. Q.—"Meminisse juvat."

W. Willby.—We quite agree with your criticism.

A. Bumpus (Loughborough).—Please send full address. The names of some correspondents who wrote in reply to your challenge were forwarded to you, and returned through the dead-letter office.

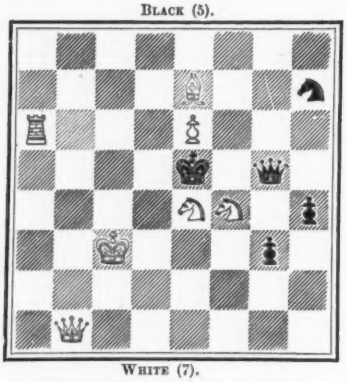
W. J. Ashdown.—Many thanks; just too late for this month.

XUM

PROBLEM.

By A. G. Fellows.

BLACK (5).



WHITE (7).

White mates in two moves.

This problem obtained the first prize in the tournament of the *Irish Times*. Mr. Fellows informs us that it is his ninth success.

CHESS INTELLIGENCE.

The tournament of the Vienna Club, after a protracted contest, resulted finally as follows: 1. Max Weiss; 2. C. Schlechter; 3. B. Englisch; 4. G. Marco. Herr Schlechter lost only one game out of more than twenty, but he drew quite half his games. The *Standard* states that a quadrangular tournament for the championship of Vienna has been arranged between the four prize-winners mentioned above.

The Whitsuntide meeting at the Craigside Hydropathic, Llandudno, begins on May 27. The competitions are the same as at the last meeting. Mr. E. O. Jones is the present holder of the Challenge Cup.

Surrey have this year come out at the head of the South-Eastern section of the Counties Chess Union. This is naturally the strongest of the four sections, and the winners should have no difficulty in securing the Cup.

In the tournament in progress at Simpson's Divan the leading scores are: R. Teichmann, won 5, lost 1; L. Van Vliet, won 3, lost 1; R. Loman, won 5½, lost 2½; H. Lee, won 3½, lost 1½. There are eight other competitors, including Mr. Bird.

A Masters' Chess Association has recently been formed; its object, apparently, is the playing of matches with the leading clubs and with foreign teams. Mr. Lasker is president, *pro tem.*, and Mr. Tinsley, secretary.

The match between J. W. Showalter and E. Kemeny resulted in a victory for the former player by seven games to four, with four games drawn. Mr. Kemeny is a Hungarian resident in the States.

The final score in the Steinitz-Schiffers match was: Steinitz, 6; Schiffers, 4; drawn, 2. The last game was drawn by mutual consent, as it could not affect the result. M. Schiffers has considerably increased his reputation by the excellent stand made against his formidable opponent.

The Championship of Scotland has, as usual, fallen to Mr. D. Y. Mills, who won all his five games. The veteran G. B. Fraser was a good second, and Mr. W. N. Walker third. Should Mr. Mills win again next year, the Challenge Cup will become his property.

The game below is a good example of Mr. Teichmann's skill. It was played in the Hastings tournament last August.

"Queen's Gambit Declined."

WHITE. (A. Burn.)	BLACK. (R. Teichmann.)
1. P to Q4	1. P to Q4
2. P to QB4	2. P to K3
3. Kt to QB3	3. Kt to KB3
4. Kt to B3	4. P to B3
5. P to K3	5. B to Q3
6. B to Q3	6. QKt to Q2
7. P to B5	7. B to B2
8. P to QKt 4	8. P to K4
9. P × P	9. Kt × KP
10. Kt × Kt	10. B × Kt
11. B to Kt2	11. Q to K2
12. B to K2	12. Castles
13. Q to B2	13. B to Q2
14. Castles	14. QR to Ksq
15. QR to Qsq	15. B to Ktsq
16. Kt to Ktsq	16. Kt to K5
17. Kt to Q2	17. P to B4
18. B to Q4	18. Kt to Kt4
19. B to Q3	19. P to B5
20. K to Rsq	20. Q to B2
21. Kt to B3	21. Kt × Kt
22. P × Kt	22. Q to R4
23. R to KKtsq	23. R to B2
24. Q to K2	24. B to K4
25. B to B2	25. R to B3
26. B × B	

Black mates in four moves.

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TWO PLATES.—1. British and English Coins. 2. Photograph of the Nebulous Region about 15 Monocerotis.

NOTICES.

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